ACRP

REPORT 80

AIRPORT COOPERATIVE RESEARCH PROGRAM

Sponsored by the Federal Aviation Administration

Guidebook for Incorporating Sustainability into Traditional Airport Projects

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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 80

Guidebook for Incorporating Sustainability into Traditional Airport Projects

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors.

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FOREWORD

By Marci A. Greenberger
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ACRP Report 80: Guidebook for Incorporating Sustainability into Traditional Airport Projects describes sustainability, its benefits, and identifies different applications in traditional airport construction and everyday maintenance projects. An accompanying CD-ROM provides an Airport Sustainability Assessment Tool (ASAT) that complements the guidebook and can be used to: assist the user in identifying sustainability initiatives that might be most applicable to an airport project, given certain criteria that the user sets; obtain more information about specific strategies; and learn about sustainability initiatives that have been implemented at other airports through case studies. The guidebook and the CD-ROM will be useful to environmental managers, planners, and consultants interested in adopting sustainability strategies and initiatives into their next airport project.

Sustainable initiatives in design and construction are becoming more common in airport improvement projects, as well as everyday maintenance activities. There is a widespread belief that incorporating sustainable initiatives into projects may have higher initial costs without understanding the benefits and/or the potential for lower lifecycle costs. In some cases, the lack of understanding and perception of increased costs has inhibited the implementation of these concepts and technologies into traditional (i.e., those projects not planned and designed with sustainability in mind) airport projects.

Landrum & Brown, Inc., under ACRP 02-22, developed guidance and an interactive tool to help airport decision makers and their staff identify and evaluate alternative sustainable design concepts and technologies in the planning and design phase. The guidance provides examples of different sustainability initiatives, average cost savings, and references for further information. The supplemental CD-ROM, in addition to providing the evaluation tool, also contains the case studies of airports and other facilities that have successfully implemented sustainability initiatives.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

SUMMARY

Guidebook for Incorporating Sustainability into Traditional Airport Projects

Sustainability has drawn a great deal of attention in the past few years as airports and many other industrial and commercial facilities have begun to consider taking steps beyond simple environmental compliance. Sustainability has offered these groups an approach for meeting environmental requirements that reduce costs while also reflecting the values of their organizations, their customers, and their local communities. The first movers among these organizations have identified processes, designs, technologies, and equipment that have successfully met these multiple goals. These strategies are now ripe for widespread acceptance. TRB's ACRP established Project 02-22, "Incorporating Sustainability into Traditional Airport Projects" to capitalize on that opportunity.

As a result of this research, this guidebook and accompanying evaluation tool, the Airport Sustainability Assessment Tool (ASAT), were developed to allow users to assess and judge what practices would be most applicable and useful for their individual airport situations/environments, and also eliminate the need to research all relevant materials on their own time and at their own expense. The guidebook also provides a reference for understanding the terminology specific to green initiatives within an airport setting.

The results of this research show that there are many opportunities for applying principles of sustainability in all areas of airport operation: airside, landside, terminals, and hangars. In the case of new buildings, runways and taxiways, maintenance facilities, and concessions, designs can easily include various sustainable approaches. Sustainability can also be applied as a component of retrofit and repair activities. While there are many beneficial opportunities for incorporating sustainable practices within the planning and design phases of an airport development project, there may be even more opportunities to consider in equipment replacement, operation, and maintenance. Furthermore, the expense of green technologies, which may often be perceived as a detriment to implementation due to higher upfront costs than traditional systems, often produce lower life-cycle costs as compared to traditional systems; and in some cases, such as balanced earthwork plans, significant cost savings can be generated when sustainable practices are incorporated instead of traditional practices.

This guidebook and accompanying Excel-based, interactive decision-making tool, ASAT, were designed to assist airport decision makers to identify and assess sustainable practices that could potentially be incorporated into traditional airport projects within their unique operating environments.

CHAPTER 1

What Is Sustainability?

Sustainability is based on a simple principle: everything needed for survival and well-being depends, either directly or indirectly, on the natural environment. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and environmental requirements of present and future generations.

Sustainable practices can reduce the environmental impact of developed infrastructure while at the same time creating financial and operational benefits for a project and social benefits for the community at large. Together, these aspects of sustainability are commonly referred to as the Triple-Bottom-Line, as shown in Figure 1.

1.1 Evolution of Airport Sustainability

The aviation industry is lacking comprehensive and easily attainable information regarding sustainable practices, methods, procedures, and technologies for an airport environment. Many airports have expressed interest in applying sustainable practices, but are reluctant, given the current lack of guidance. The comprehensive collection of data that was analyzed throughout this study helps to bridge the gap between efficient, real-world applications and the industry.

Green and sustainable practices are measures incorporated into projects that are designed to produce balanced environmental, social, and financial benefits. Sustainable practices are designed to reduce impact on the environment by reducing the use of raw or material resources (materials, fossil fuels, energy consumption, etc.), reducing air emissions, reducing waste, reducing water pollution, mitigating increased flooding from stormwater runoff, and many more. Thoughtful planning to incorporate green and sustainable practices helps to reduce environmental impacts while also creating financial and operational benefits.

Airports have been challenged in recent years to do more with less—reduced budgets, limited staff—due to constrained resources as a result of the international aviation system being stressed by terrorist acts, threats of infectious pandemics, and a worldwide recession. At the same time, new goals for improving environmental performance have been proposed at national, regional, and local levels; for example, cities, states, and regions are setting goals to reduce greenhouse gas (GHG) emissions, which will require doing things differently in the future. Against this backdrop, airports must still look ahead and plan to meet projected increases in demands for air travel. To preserve economic viability and address potentially formidable constraints to growth, airports need strategies that allow for sustained aviation growth while controlling costs and pursuing a goal of reducing environmental impacts over time.

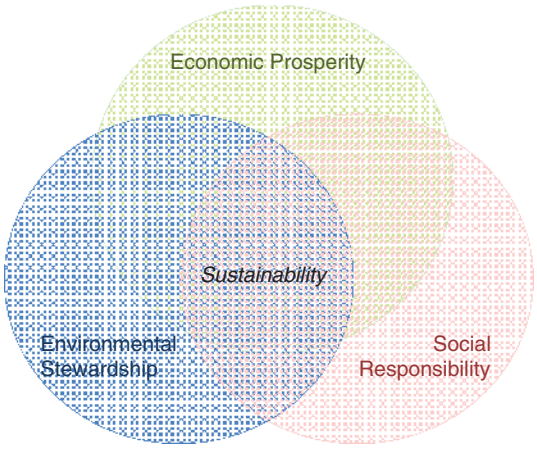

Figure 1. The Triple-Bottom-Line

Managing operating costs and capacity, reducing environmental risks and liability, and ensuring customer and employee satisfaction, while demonstrating a commitment to the health and vitality of their communities, is the new order of business. Sustainable development combines ecological, social, and economic concerns into a Triple-Bottom-Line that represents a promising approach to meet the unique challenges facing airports today. This approach has recently drawn a great deal of attention within the airport community.

1.2 Comparison to Conventional Design Concepts

There are opportunities for applying principles of sustainability in all areas of airport operation: airside, landside, terminals, and hangars, just to name a few. New buildings, runways and taxiways, maintenance facilities, and concessions can all be designed using sustainable approaches. Sustainability can also be applied as a component of retrofit and repair activities. The most beneficial opportunities for employing sustainable principles may be during the planning and design phases of an airport development project, but there may be even more opportunities to consider in equipment replacement and maintenance.

For example, consider the flooring material for an airport terminal. During the original design, the decision on whether to install carpet, tile, or stone flooring may be made. Carpet will have the lowest first cost but it may have to be replaced within three years, which will create a waste stream and a cost to the operating department. And the adhesive used to install the carpet may emit fumes that are a source of indoor air pollution. Alternatively, stone or hardwood will last the life of the facility, it may be available locally, minimizing transportation costs, and can be reused at the end of the terminal's lifetime. If the decision was originally made to install carpet, when replacement is required, an alternative could be considered such as bamboo. Bamboo is a rapidly growing type of grass that can be manufactured into tough, resilient flooring that is durable yet biodegradable when it reaches the end of its useful life. This is just one example of technological advancements in product technology that have reduced impacts to the environment and save operating costs over time.

There are challenges to implementing sustainable initiatives beyond identifying appropriate processes or technologies. When new facilities are designed and built, there is a strong impetus to hold down the construction and materials costs to adhere to capital budgets. When contractors and subcontractors are solicited, there is a preference for the low bid. And when materials are

requisitioned, the low cost supplier frequently wins the contract. Throughout the facility design and construction, decisions are made based on the goals of the project team, usually total cost and time to completion. Once the facility is turned over to begin routine operations, however, the operating department has different cost concerns and goals driving its decisions, usually monthly or yearly operating costs. In fact, up to 75% of the cost of facility ownership occurs after design and construction and the operating departments must live with decisions made by the capital project team.

To ensure their success, sustainability programs must begin during planning and design and continue through construction and operation/maintenance, as well as decommissioning and demolition. This approach takes into account the lifetime impacts of processes and equipment and minimizes not only total costs but also lifetime environmental impacts.

The expense of green technologies, which may often be perceived as a detriment to implementation due to higher upfront costs than traditional systems, often produce lower life-cycle costs as compared to traditional systems. In some cases, significant cost savings can be generated when sustainable practices are incorporated instead of traditional practices.

The following comparisons of sustainable and traditional practices provide sample cost savings over time for the sustainable options. Sample comparisons include:

- Design of Physical Structures
  - Green roof versus conventional roof
  - Energy efficient lighting versus traditional incandescent
  - Double glazed windows versus traditional
- Construction Practices
  - On-site balanced earthwork plan versus traditional off-site hauling
- Daily Operations
  - Recycling
  - Water efficiency
  - Double-sided printing
  - Green cleaning products
- Social Benefits of Sustainability

1.2.1 Green Roof Versus Conventional Roof

Table 1 presents a sample of a 31-year cost-benefit comparison for a 25,000 square foot green roof versus a conventional roof of the same size.

1.2.2 Energy Efficient Lighting Versus Traditional Incandescent

Comparison of Outdoor LED Airfield Lighting (Taxiway Edge Lights and Runway Guard Lights) to Standard Existing Airfield Lighting

Typical Existing Equipment for Airfield Lighting. Incandescent Elevated Runway Guard Lights and the existing Elevated Taxiway Edge Lights operating continuously 24 hours per day, 7 days a week; existing equipment typically operates at 20–25W both with and without the heating element in operation.

LED Replacement Equipment. LED Elevated Runway Guard Lights and LED Elevated Taxiway Edge Lights operating continuously 24 hours a day, 7 days a week; replacement LED equipment typically operates at 25VA with the heater on and at 12VA with the heater off. Manufacturers typically estimate 1.8 times the energy savings as compared to the existing equipment with the heater on and 3.7 times the energy savings with the heater off.

Table 1. Cost-benefit comparison.

COMPARISON ELEMENT	GREEN ROOF 25,000 sq. ft. vegetated surface	CONVENTIONAL ROOF 25,000 sq. ft. asphalt surface
Initial Capital Expense	$300,000	$225,000
Cost per Square Foot	$12/sf	$9/sf
Average Life Expectancy	40 years	10 years
Capital Expense/Inflation in year 31	$300,000 (original roof)	$1,154,595 (replaced twice)
Maintenance Costs/Inflation in year 31	$26,607	$26,607
Life Cycle Costs in year 31	$270,447	$359,682
Energy Cost Reduction/ Thermal Insulation	Approximately 30% summer reduction of air conditioning requirements and 25% winter reduction of heating requirements (with a 3-7 degree interior temperature reduction in the summer and increase in the winter)	None
Sound Insulation	Green roof with a 5 inch substrate layer can reduce sound by 40 decibels	Minimal
Air Quality Improvement	100 square feet of grass roof can remove 4.5 pounds/year of airborne particulates; 25,000 sq. ft. equates to approximately 1,125 pounds/year reduction of airborne particulates	None
Stormwater Retention	In summer, green roofs retain 70-90% of the precipitation that falls on them; in winter they retain between 25-40%.	None
Temperature Regulation	Moderation of the Urban Heat Island Effect: roughly 10.76 sq. ft. of foliage can evaporate 0.13 gallons of water per day and 47.5 gallons of water per year	Minimal
Visibility of Environmental Commitment	Enhances public image and emphasizes commitment to environmental stewardship	None
Conclusions: Initial expenses incurred with a conventional roof are $75,000 less than a green roof. However, after 31 years, the conventional roof had to be replaced twice, while the green roof did not yet need replacement. The cost savings in capital expenses associated with the green roof are estimated to be nearly $850,000. Maintenance costs for both roofs are the same. While the conventional roof is the least expensive initially, it also offers the shortest life cycle of 10 years and the highest capital expenses, having to be replaced two times in 31 years. Although the green roof has a higher initial capital expense, it offers the most benefits over time, offering a life cycle of 40 years, four times longer than a conventional roof. The green roof has no additional capital expenses after 31 years because it did not need to be replaced. In addition to cost savings, green roofs offer advantages in sound insulation, air quality improvements, stormwater management, temperature regulation, and public relations opportunities.		

Calculation Method. Savings are calculated per fixture at 24 hours multiplied by 365 days. In calculating total cost savings when converting airfield incandescent lighting fixtures and lamps to LED, consideration must be given to both reduced energy and labor costs. For example, if 1,150 airfield fixtures are converted to LED, the combined annual savings from energy and labor for this lighting conversion is approximately $299,000 per year. The combined cost of equipment and labor to complete this lighting conversion is typically approximately $675,000. Therefore, when dividing the total project cost by the annual savings per year, a payback period of 2.25 years is realized. Conversely, dividing the annual savings by the total project cost, a return on investment (ROI) of 44.3% can be realized.

Expected Measure Life (Years):

- Taxiway Edge Lights: Average LED life of 100,000 hours under high-intensity conditions (or 11.4 years) and more than 200,000 hours (or 22.8 years) under actual operating conditions.
- Runway Guard Lights: Average LED life of 56,000 hours under high-intensity conditions (or 6.4 years) and more than 150,000 hours (or 17.1 years) under actual operating conditions.

Table 2 shows the comparison between traditional incandescent bulbs and other bulbs.

Table 2. Comparison of Indoor 60 watt (W) traditional incandescent bulbs with energy efficient bulbs that provide similar light levels.

Comparisons between Traditional Incandescent and Energy Efficient Light Bulbs				
	60W Traditional Incandescent	**43W Energy-Saving Incandescent**	**15W CFL**	**12W LED**
Energy $ Saved (%)	–	~25%	~75%	~75-80%
Annual Energy Cost per bulb*	$57.60	$42.00	$14.40	$12.00
Bulb Life	1000 hours	1000 to 3000 hours	10,000 hours	25,000 hours

*Based on 24 hrs/day of usage, an electricity rate of 11 cents per kilowatt-hour, shown in U.S. dollars.

Source: "How Energy-Efficient Light Bulbs Compare with Traditional Incandescents," U.S. Department of Energy, accessed May 31, 2012, http://www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=12060

1.2.3 Double Glazed Windows Versus Traditional

Double glazing, or insulated glazing, refers to double glass window panes separated by trapped air. The benefits of double glazing include improved energy efficiency and reduced energy costs due to reduced heat loss in the winter and reduced cool air loss in the summer; controlled condensation; and reduced noise transmission.

Improved Energy Efficiency and Reduced Energy Costs

Reduced Heat Loss during the Winter. The insulating layer of double glazing reduces the effect of outside cold temperatures on building interiors. A shift from single glazing to double glazing can reduce heat loss through glass by up to 50%.

Reduced Cooling Loss during the Summer. Likewise during the summer, the insulating layer of double glazing reduces the effect of outside warm temperatures (or solar heat gain) on building interiors. A shift from single glazing to double glazing can reduce solar heat gain by roughly 13%.

Energy Cost Savings. The Food Marketing Institute, in cooperation with the U.S. EPA, promotes the installation of double glazing in retail supermarkets, stating that the following savings can be achieved with a double-glazed sky-lighting installation that covers 4.5% of a ceiling area:

Installed Cost: $168,000
Electric Rate/kWh: $.10
Gas Cost/Year: $26,780
Electric Cost/Year: $150,670
Total Energy Cost/Year: $177,450
Energy Cost Saved/Year: $24,050
Simple Payback: 7 years

Controlled Condensation

Condensation forms when warm air is cooled. In the case of a window or glass area, the moisture in the air condenses on the glass forming what can be significant amounts of water. In the case of single glazing, the cool temperature on the outside transfers easily to the inside and condensation occurs rapidly. When double glazing is installed, improved thermal insula-

tion between the outside and inside results in greatly reduced condensation and warmer, drier interior space.

Reduced Noise Transmission

Double glazing can also provide a significant reduction in outside noise that is transmitted to interior space. The trapped air between both layers of glass improves noise insulation quality of the glass by reducing the amount of sound transmitted through the glass to the interior space.

Summary

The U.S. EPA recommends that large-scale facilities, which experience higher energy costs than nearly all other building types, gain efficiency from integrated design practices, including systems to control heat gain, such as double glazed windows. Unmanaged solar energy through the use of standard single glazed windows can increase the heating load of a facility, demanding more of the air conditioning systems; similarly, windows with a poor ability to keep heat in allow warm air to escape a building in the winter, increasing the demands on heating systems. (See "Designing for Energy Efficiency," Food Marketing Institute.)

1.2.4 On-Site Balanced Earthwork Plan Versus Traditional Off-Site Hauling

The benefits of a Balanced Earthwork Plan as part of an airport construction project are presented in Table 3, courtesy of the Chicago Department of Aviation.

1.2.5 The Cost Savings of Recycling

Recycling is the transfer of material out of the waste stream and diverting it from landfills so that it can be reused, repurposed, or remanufactured into new products. As the volume of waste sent to landfills decreases, the cost of such trash disposal also decreases.

Establishment of a recycling program can provide appreciable cost savings. Initial costs to plan and implement the program, including the purchase of bins and pick-up/sorting service, if needed, will eventually be offset by reduced trash disposal fees and less waste creation over time. Material costs often include the purchase or leasing of collection bins, storage containers, container signage and employee education literature, and the cost of transporting recyclable materials to an off-site processing facility.

Table 3. Balanced Earthwork Plan benefits analysis through 2010

Quantities	Description
over 18 MCY	Cubic yards of Soil Moved
over 6.3 MCY	Cubic yards of Excess Soil Kept On-site
over 575,000	Haul Trips Saved
over 1 Million	Hours of Roadway Travel Saved
over 43 Million	Vehicle Miles Traveled (VMT) Saved
over 6.5 Million	Gallons of Diesel Fuel Saved
over $126 Million	Dollars Saved
approximately 72,000	Tons of CO_2 Saved

Source: Chicago Department of Aviation, O'Hare Modernization Program, 2010, e-mail message to authors, April 12, 2011.

In addition to cost savings, recycling saves energy that would be used to extract resources or create products from virgin materials. Recycling also creates more jobs than traditional trash disposal services. For every one job at a landfill, there are 10 jobs in recycling processing and 25 jobs in recycling-based manufacturing. The recycling industry employs more workers than the auto industry (Eco-cycle, accessed May 31, 2012).

1.2.6 The Cost Savings of Water Efficiency

The U.S. EPA provides a variety of guidance to increase water efficiency for both indoor and outdoor use, with the end result of cost savings in mind.

Outdoor Water Efficiency

Water-Efficient Landscaping. Proper landscaping techniques not only create beautiful landscapes, but also benefit the environment and save water. Water-efficient landscaping produces attractive landscapes because it utilizes designs and plants suited to local conditions. Water-efficient landscaping offers many economic and environmental benefits, including:

- Reduced landscaping labor and maintenance;
- Lower water bills from reduced water use;
- Extended life for water resources infrastructure (e.g., reservoirs, treatment plants, groundwater aquifers), thus reduced taxpayer costs;
- Decreased energy use (and air pollution associated with its generation) because less pumping and treatment of water is required;
- Reduced runoff of stormwater and irrigation water that carries top soils, fertilizers, and pesticides into local receiving bodies;
- Reduced heating and cooling costs through the careful placement of trees;
- Fewer trimmings to be managed or land-filled;
- Reduced landscaping labor and maintenance costs; and
- Coupled with a rainwater collection system, water for future irrigation can be stored on-site.

Example Program. Pacific Northwest National Laboratory (PNNL) operates an award-winning grounds maintenance program that comprises a comprehensive landscape and irrigation management program. The program has helped the laboratory reduce its water use for irrigation by 30%. The program began in 2000 and, at the time, was implemented with their 35-year-old landscape. PNNL has more than 4,200 staff members, sits on 600 acres, and houses 2 million square feet of facilities. The program encompasses sound landscape design and maintenance of the plants and efficient application of water to these plants.

The PNNL landscape and irrigation management program has resulted in the following annual savings:

- 30% reduction in water consumption for turf irrigation;
- 15 million gallons of water reclaimed from the cooling ponds for irrigation;
- $30,000 in reduced wastewater fees from reclaiming cooling pond water instead of sending it to the wastewater treatment plant; and
- 200,000 kilowatt-hours (kWh) of electricity saved from reducing water pumping from the Columbia River.

(Pacific Northwest National Laboratory Grounds Maintenance, U.S. Department of Energy)

Indoor Water Efficiency

U.S. EPA's WaterSense Program: Saving Water Saves Energy. The U.S. EPA's WaterSense Program was created to encourage the use of water-efficient products and practices among consumer and commercial audiences. The main goal of the program is to decrease indoor and

outdoor nonagricultural water use through more efficient products, equipment, and programs. With its recognizable label, WaterSense helps consumers easily identify water-efficient products in the marketplace while ensuring product performance and encouraging innovation in manufacturing.

Many people understand the importance of saving energy, and many also understand the importance of saving water. However, few know about the direct connection between saving both. It takes water to create energy. Vast amounts of water are used to cool the power plants that generate electricity. Because approximately 4% of the nation's electricity consumption is used moving or treating water and wastewater, one of the best ways to save energy across the country is to use water more efficiently.

A relatively simple way to save both water and energy is to install water-efficient plumbing fixtures, including toilets, sink faucets, and faucet accessories. The U.S. EPA has labeled "WaterSense" toilets, bathroom sink faucets, and faucet accessories that have been proven to save resources and perform to consumer expectations. WaterSense labeled products must achieve independent, third-party testing and certification to prove they meet U.S. EPA's criteria for both efficiency and performance ("WaterSense," U.S. EPA).

1.2.7 The Benefits of Double-Sided Printing

Double-sided printing is one the easiest ways to save money, reduce waste, and improve your carbon footprint. If your printers already have the ability to print double-sided, then making a simple change on the default settings can substantially reduce the amount of paper used.

There are several free tools available on-line that allow exploration of the potential savings accompanying a change to double-sided printing. One example is found at Appropedia (http://www.appropedia.org/Double-sided_printing).

In addition, publicly available research into the savings that can be achieved through sustainable office practices has found the following:

Key Points

- The costs of document output can be reduced by up to 30% through the active management of office printing practices.
- The use of double-sided printing as a default setting on office equipment can reduce annual paper costs by up to 30%.
- The active support from Senior Management in informing employees of the purpose of such practices will enhance the success of the initiative.

("Double-Sided Printing," Appropedia; "How to Reduce Printing Costs by 17%: A Guide to Doing Well and Doing Good by Printing Less," GreenPrint Technologies)

1.2.8 The Benefits of Green Cleaning Products

Cleaning products are necessary for maintaining attractive and healthful conditions in the workplace. In addition to the obvious aesthetic benefits of cleaning, the removal of dust, allergens, and infectious agents is crucial to maintaining a healthful indoor environment. But cleaning products can present several health and environmental concerns. They may contain chemicals associated with eye, skin, or respiratory irritation, or other human health issues. Additionally, the concentrated forms of some commercial cleaning products are classified as hazardous, creating potential handling, storage, and disposal issues for users. Reducing the human health and environmental concerns is an important incentive for implementing a Green Cleaning Products Program ("Greening Your Purchase of Cleaning Products: A Guide for Federal Purchasers," U.S. EPA).

Key Points

- Buying cleaners in concentrates with appropriate handling safeguards, and reusable, reduced, or recyclable packaging, reduces packaging waste and transportation energy.
- Buying less hazardous cleaners may reduce costs when it comes time to properly dispose of any leftover cleaners.
- Choosing less hazardous products that have positive environmental attributes and taking steps to reduce exposure can minimize harmful impacts to custodial workers and building occupants and improve indoor air quality, as well as reduce water and ambient air pollution while also ensuring the effectiveness of cleaning in removing biological and other contaminants from the building's interior.

What Makes a Cleaning Product Green?

Product Content and Use

- Minimal presence of or exposure to potentially harmful chemicals, such as:
  - Corrosive or strongly irritating substances
  - Human carcinogens or reproductive toxicants
  - Ozone-depleting compounds
  - Regulated hazardous materials
- Use of renewable resources
- Low VOC content
- Biodegradable
- Low toxicity
- Low flammability
- Designed for use in cold water in order to conserve energy

Product Packaging and Shipping

- Concentrated formulas with appropriate handling safeguards
- Efficient packaging (e.g., light weight, reduced volume)
- Recyclable packaging
- Recycled-content packaging
- Refillable bottles
- Pump sprays rather than aerosols
- Packaging and dilution systems designed to reduce exposure to the product
- Products shipped in bulk
- Clear labeling and information on use and disposal

Corporate Environmental Performance

- Manufactured by a company with any of the following:
  - Formal environmental management system
  - International Organization for Standardization (ISO) 14001 certification
  - Formal partnership with the Design for the Environment Formulator Initiative

1.2.9 Social Benefits of Sustainability

Calculating an economic payback on the implementation of social sustainability programs can be challenging. However, the contributions to the local community will be clearly evident. ("The Social Benefits of Sustainable Design," U.S. Department of Energy, Federal Energy Management Program; Harriet Baskas 2010),

The social benefits of sustainability are related to improvements in a person's quality of life, health, or well-being. These benefits can be the direct result of spending time in an occupied

building that has been sustainably designed/constructed or they can be the result of a program or event that has led to their improved quality of life, health, or well-being.

From a public health perspective, quality of life can be measured in terms of individual life expectancy and state of wellness and can include environmental quality, aesthetics, educational and recreational opportunities, accessibility and quality of public services, and community satisfaction and pride.

The following are examples of social sustainability initiatives in place at airports:

- Las Vegas McCarran International Airport donated surplus walk-through metal detectors to the local school district for use at dances and sporting events following its upgrade of security checkpoint equipment in 2005.
- Oakland International Airport, as part of its 2008 terminal improvement program offered the removed gate seating to any local non-profit that was interested. The Boys & Girls Clubs of Oakland is now using the seating.
- At Seattle-Tacoma International Airport, unsold food from concessionaires is sent to area food banks.

CHAPTER 2

Purpose and Structure of the Guidebook and ASAT

To successfully implement a sustainability program, especially in an era of limited staff and less specialization, the TRB ACRP realized that airports could use a clear, simple guidebook for incorporating sustainability into traditional airport projects.

2.1 Research Approach

This research project was commissioned by the ACRP with the stated objective of developing a guidebook that airports can use to assist in evaluating sustainable design and technology alternatives during the planning and design phases of airport project developments.

As a result of this research, a guidebook and accompanying Excel-based, interactive decision-making tool, the ASAT, were designed to assist airport decision makers to identify and assess sustainable practices that could potentially be incorporated into traditional airport projects within their unique operating environments.

A glossary of terms and definitions relevant to sustainability initiatives and practices is included in Appendix A, Glossary of Terms and Definitions.

A comprehensive collection of sustainable strategies for consideration at an airport is presented in Appendix B, Sustainable Initiatives for Incorporation Into Traditional Airport Projects.

A review of sustainability-related literature, research, published guidance, and other materials was completed in order to gain an understanding of the most current information and materials relevant to sustainable practices at airports, as well as sustainable practices in use at non-airport industries that would be applicable to airports. The results, drawn from numerous public and private-entity sources, are presented in Appendix C, Resources and References.

Nineteen facilities were identified that warranted further investigation as case studies. The collection of case study information is available through the ASAT.

2.2 Who Should Use the Guidebook and ASAT

The aviation industry is lacking comprehensive and easily attainable information regarding sustainable practices, methods, procedures, and technologies for an airport environment. This guidebook and accompanying ASAT serve to fill that void.

The valuable information gained through the research and case studies completed for this project was used to develop this guidebook and the ASAT that allow users to determine, evaluate, and judge what practices would be most applicable and useful for their individual airport

situations/environments, and also strives to eliminate their need to research all relevant materials on their own time and at their own expense.

This guidebook and accompanying ASAT are intended for use by airport decision makers in identifying sustainable design concepts and technologies that could be considered for implementation in their unique operating environments and providing information about sustainable design concepts and technologies that are already under consideration by other airport decision makers.

2.3 How to Use the Guidebook and ASAT

This guidebook and ASAT can be used together or separately, depending on the needs of the user. All data collected through industry research and through the case study process are included in the guidebook and assessment tool, as well as all suggested sustainable strategies for implementation in an airport environment.

Within this guidebook, Appendix B, Sustainable Initiatives for Incorporation Into Traditional Airport Projects, presents detailed sustainable strategies for airports to incorporate into traditional planning, design, construction and everyday operations/maintenance projects, under the major areas listed below:

- Administrative procedures
- Social responsibility
- Planning process
- Sustainable site management
- Site selection and management
- Water efficiency
- Energy and atmosphere
- Materials and resources
- Indoor environmental quality
- Construction practices
- Encouraging tenants and concessionaires to operate sustainably

Like Appendix B to this guidebook, the assessment tool presents the same detailed sustainable strategies for airports to incorporate into traditional planning, design, construction and everyday operations/maintenance projects. However, ASAT is interactive and guides the user through the basic framework of a sustainability decision-making process. In addition, ASAT offers results for users who are on three different tracks of desired assistance: (1) those who are already considering implementation of a particular sustainability strategy and want to know more about it; (2) those who are searching for ideas of sustainability strategies for potential implementation at their airport; and (3) those who are interested in learning what sustainability initiatives other airports have implemented.

CHAPTER 3

Approaching Sustainability at Airports

While there is no one sustainability practice or initiative that will work at every airport, the results of this research have shown that two elements are prevalent at airports with sustainability success stories: (1) the organization has a "champion" of sustainability and (2) the organization has a sustainability plan. This section describes these elements and provides background on the common challenges associated with each (Figure 2).

3.1 Vision and Innovation

A sustainability champion can be one person or it can be a group of people who believe in the benefits of sustainability and are willing to address the questions and concerns of those decision makers and stakeholders who are skeptical. A champion will help direct the organization toward a cohesive vision for sustainability. In addition, support from leadership allows frontline staff to view an idea as both adaptable to the local airport environment, as well as compatible with other materials/existing values or culture within the organization as a whole.

3.1.1 Applicability to Airports of All Sizes

There is increasing attention to and awareness of green and sustainable initiatives in design and construction, not only in commercial and residential properties, but in airport improvements as well. There is widespread belief that incorporating these initiatives into projects may have higher initial costs, but there is little knowledge as to what the benefits may be. In some cases, lack of understanding and perception of increased costs has inhibited the implementation of these concepts and technologies into traditional airport projects, particularly those projects not planned and designed with sustainability in mind. In addition, there is the perception that only major commercial service airports can benefit from sustainable initiatives due to large capital investments that must be made.

3.1.2 Common Challenges

Deciding to pursue a sustainable approach and understanding how to proceed toward that goal are two different things. While many airports are intrigued about incorporating sustainability in their planning, many questions arise about how and where to begin. Common challenges among champions of sustainability within an organization are adequately addressing the concerns of decision makers who frequently want to know: What resources are available? How do you compare conventional equipment and technology with new equipment or approaches? What is important for integrating new equipment into existing systems and how do you ensure you achieve the expected benefits? What works and what doesn't? Will this really save money

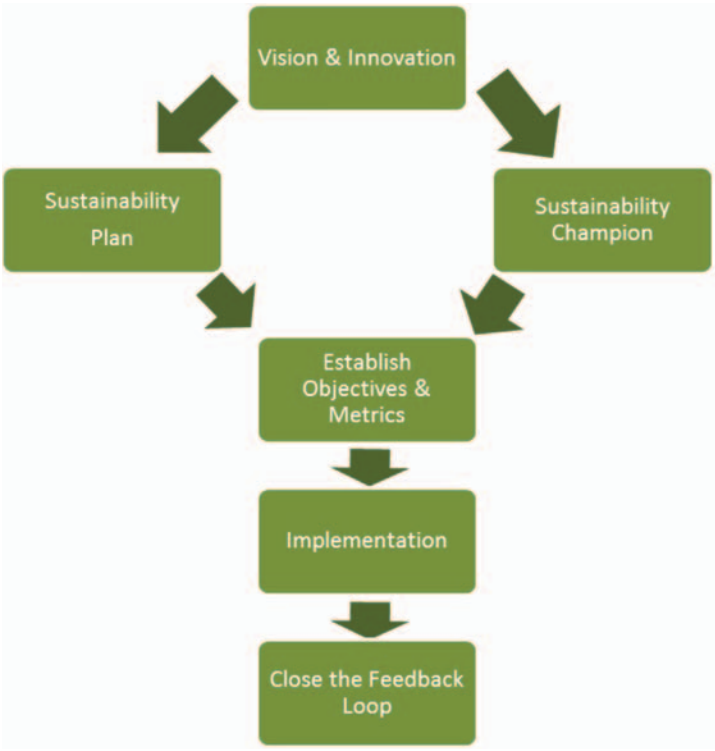

Figure 2. Flowchart to approaching sustainability at airports.

in the long term? The case studies conducted through this research sought to answer these important questions.

Through the research and case studies, it has been determined that those who incorporate sustainability into their projects save time and money; that is what the industry is reporting overall.

3.2 Developing a Sustainability Plan

A sustainability plan can be developed for an organization as a whole and/or for a specific project. When developed for an organization as a whole, it can be as simple as a Corporate Sustainability Policy or Vision Statement. When developed for a project, it can be a description outlining what is to be improved, retrofit, upgraded, replaced, enhanced, or corrected as a result of the project completion, and this can be developed for all projects regardless of size, scope, or scale. The description of the project should be as comprehensive as possible and include (as appropriate) regulatory, guidance, and operational documents. In either case, the goal is to define in writing, a statement, which at a minimum, clearly states an organization's or a project's sustainability vision and/or goals.

3.2.1 Establishing Objectives and Metrics

Moving beyond development of a basic vision statement and high-level sustainability goals, it can be beneficial to also develop specific objectives to meet in pursuit of each goal, as well as the metrics used to determine when or how the goal will be met.

The following are examples of sustainability objectives, target goals, and minimum thresholds that can be identified and established for an overall organizational sustainability plan and a specific sustainability plan developed for a project:

- Reduce energy use per square foot of facilities on a percentage basis or on a per passenger or customer basis
- Increase use of renewable energy on a percentage basis
- Reduce water use on a percentage basis
- Reduce number of pollutant exceedences and concentration of pollutants at the "end of the pipe" (e.g., SADF, pH, TDS, petroleum sheens)
- Identify and reduce sources of pollutants
- Reduce percentage of failed Best Management Practices (BMPs)
- Reduce number of noise complaints received and incompatible land uses authorized in adjacent cities
- Reduce the volume of solid waste generated from sources airport-wide
- Increase volume of recycled waste generated from sources airport-wide
- Reduce volume of hazardous waste generated
- Increase procurement of environmentally friendly products
- Increase staff, tenant, and/or public education and outreach initiatives, including, but not limited to the following:
  - Develop Environmental Stewardship Training ("Eco-Training") for employees, contractors, tenants, concessionaires
  - Implement or require training programs as part of tenant leasehold
  - Provide educational materials to passengers and visitors in public terminal areas, gate holdrooms, parking areas, and similar areas
  - Use kiosks and informational displays to inform and generate interest

3.2.2 Closing the Feedback Loop

In order for plans, goals, and objectives to be truly sustainable, it is important for key managers, decision makers, and stakeholders to meet periodically to determine if plans are working and, if not, how to make improvements. The following questions are designed to facilitate discussions at such meetings:

- Are the goals, targets, and measures reasonable? Why or why not?
- Were the planned sustainability measures implemented? Why or why not?
- Were additional sustainability measures that were not originally identified implemented? Why or why not?
- Are sustainability goals and targets on track to be met? Why or why not?
- Are the anticipated benefits on target to be achieved? Why or why not?
- Are the tracking and reporting mechanisms working as anticipated? Why or why not?
- Are there recommended improvements, enhancements, or "lessons learned" that can be applied to future projects?

CHAPTER 4

Implementation Process

4.1 Organization Readiness

As previously stated, while there is no one sustainability practice or initiative that will work at every airport, the results of this research have shown that two elements are prevalent at airports with sustainability success stories: the organization has a champion of sustainability and the organization has a sustainability plan.

A sustainability champion can be one person or it can be a group of people who believe in the benefits of sustainability and are willing to address the questions and concerns of those decision makers and stakeholders who are skeptical. A champion will help direct the organization toward a cohesive vision for sustainability.

An organization's or a project's sustainability plan or vision statement is a clearly defined, written statement of an organization's or a project's sustainability vision and/or goals.

Without one of more of these elements in place, the airport as an organization will not be able to fully consider sustainability program needs and resources or embrace innovations. Successful implementation of sustainability practices or initiatives requires support from leadership either formally, through an airport-wide or project-specific sustainability plan, or informally, in order for it to be viewed by frontline staff as being adaptable to the local airport environment and for it to be further viewed as compatible with other materials/existing values or culture within the organization as a whole.

4.2 Criteria for Evaluating Sustainability Concepts and Technologies

As a result of the case study interviews conducted for this project, this section presents a list of criteria for evaluating sustainability concepts and technologies under consideration for implementation within an organization. See ASAT for specific examples of the decision-making processes at airports and other similar facilities.

4.2.1 Time, Budget, Scope, and Feasibility Considerations

When considering sustainable initiatives for incorporation into an airport environment, it is important to also keep in mind the key criteria of time, budget, scope, and feasibility. The following outline includes all four key criteria and presents questions for airport decision makers to consider and attempt to answer with key stakeholders in order to fully vet an initiative prior to implementation in their organization. This list of criteria also provides the structure of the interactive ASAT, which accompanies this guidebook.

1. TIME
   a. Urgency: What is the time frame and is it a dependent or independent project?
      i. Is it an urgent requirement? Must something be done immediately?
      ii. Is it associated with a larger capital project, such as a runway addition, terminal expansion, etc.?
      iii. Is it a near-term requirement?
      iv. Is it a longer-term requirement?
   b. Time to Implement
      i. What is the range of time (in months) needed to plan, develop, and implement the initiative?
         1. If different, what is the range of time (in months) before the initiative is functional?
      ii. What schedule can be established?
      iii. Is it dependent on a new or emerging technology?
      iv. What permits and/or approvals from outside agencies would be required?
2. BUDGET
   a. Economics
      i. What are the results of the life-cycle analysis or payback analysis, assuming a standard ROR or ROI for the airport?
         1. Have the values for initial installation and for annual operating costs been thoroughly researched and vetted?
      ii. Can the project compete on life-cycle costs, or must it compete on first cost?
         1. What is the approximate payback period the project must meet?
         2. What are the initial costs versus the operating costs?
      iii. What are the results of the useful life analysis?
         1. Can the project be completed in such a way that deconstruction/demolition/decommission at the end of its useful life allows for easy reuse into other projects?

Examples for conducting a cost/benefit analysis include, but are not limited to the following:

California Department of Transportation Guide to Benefit-Cost Analysis: http://www.dot.ca.gov/hq/tpp/offices/

The Environmental Valuation and Cost-Benefit Analysis web site: *www.costbenefitanalysis.org/*

Examples for conducting a Life Cycle Cost Analysis (LCCA) include, but are not limited to the following:

Federal Energy Management Program (FEMP): *www1.eere.energy.gov/femp/program/lifecycle.html*

National Institute of Building Sciences, Whole Building Design Guide: *www.wbdg.org/resources/lcca.php*

Federal Highway Administration: *www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.cfm*

Examples for conducting a Life Cycle Assessment (LCA) include, but are not limited to the following:

ISO 14040, *Environmental Management Life Cycle Assessment Principles and Framework: www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=37456*

EPA National Risk Management Research Laboratory: *http://www.epa.gov/nrmrl/std/lca/lca.html*

      iv. Are external funds necessary (i.e., federal, state, local, private grants)?
      v. What are the external funding options available, such as VALE, AIP/PFC, Clean Cities, etc.?

There are many opportunities for grants, rebates, tax incentives and credits available from federal, state and private sources. For example:

> *www.dsireusa.org* is a comprehensive source of information on state, local, utility and federal incentives and policies that promote renewable energy and energy efficiency.
>
> eCivis® Grants Network™ *(www.ecivis.com)* provides grants management software for accurate grants information, reporting, and management used by governments and community organizations.

ACRP Synthesis 24: Strategies and Financing Opportunities for Airport Environmental Programs (http://onlinepubs.trb.org/onlinepubs/acrp/acrp_syn_024.pdf). The purpose of this ACRP synthesis is to provide a comprehensive summary of those funding opportunities, programs, and strategies available to airports to assist them in meeting their environmental responsibilities or undertaking environmental initiatives.

vi. Could it be considered a test or demonstration of the concept or technology?
vii. What are the project delivery techniques and methods that would be anticipated?
1. Design/Bid/Build?
2. Design/Build?
3. Other?

b. Staffing
i. Can the project be implemented and/or completed with existing staff, or would new staff be required?
1. Would training of new or existing staff be required?
ii. Would implementation/completion of the project require outside consultants, vendors, or other special expertise?
1. If yes, at what level of involvement?

c. Technology
i. Would implementation/completion of the project require proprietary hardware, equipment, software, mandatory service agreements, or other similar technology?

3. SCOPE
a. Policy and Vision: What is motivating this initiative or technology?
i. Internal
1. Executive initiative and/or champion driving this?
ii Community posture
1. Is the local community socially or environmentally active?
2. Have they made a specific request or do they simply want results?
iii. External mandate
1. State or municipal political goal or requirement?
2. Federal or state legal requirement?

b. Operating Motivation
i. Expand capacity?
ii. Improve efficiency?
iii. Reduce cost?
iv. Opportunity for vision and innovation?
v. Enhance or improve the passengers' experience?
vi. Enhance social aspects of sustainability?
1. Does it support good-neighbor policies and/or public relations efforts?
vii. Promote environmental/regulatory compliance?
viii. Other?

c. Essential Stakeholders
i. Who must be involved and who should be involved?
1. Airport staff
2. Airport management

3. Airlines
4. Tenants
5. Passengers
6. FAA
7. Other regulatory agencies (state environmental agency, EPA)
8. Municipal politicians
9. Elected officials
10. Local citizens and/or businesses
11. Building inspectors
12. Local utility companies
13. Designers and contractors
    a. Engineers, architects, general contractors, and similar can be involved at varying levels; the minimum of which would be to provide basic information/questions to ask that would assist the stakeholders in making an informed decision
14. Other?

d. Environmental/Compliance-related Issues
   i. Although sustainability does not equal compliance, the two can be related.
      1. Is this required for compliance?
      2. Will it improve compliance?
      3. What are the significant environmental impact areas (emissions reductions, energy conservation)?
      4. How will implementation of the initiative affect the environmental impact areas?
      5. How will implementation of the initiative affect the airport's carbon footprint?

4. FEASIBILITY
   a. Geographical/Regional
      i. Is this an appropriate location for this initiative (i.e., solar, hydro, geothermal, wind, etc.)?
   b. Land Use and Physical Constraints
      i. What are the real estate goals (i.e., highest and best use identified) for property within the airport boundary, as defined by airport management?
         1. Does this initiative conform with or contradict those goals?
         2. Is there an opportunity for 3rd party involvement?
            a. Could the land be developed as a concession or land lease by an outside entity/private firm with no upfront funding by the airport?
         3. What are the space constraints within the airport property boundary?
         4. Is currently open space already earmarked for another project?
      ii. What are the physical space requirements for the initiative vs. what is available on-site?
      iii. Are there aeronautical compatibility issues, as defined by FAA?
         1. Would it cause issues with bird attractants, visual hazards for pilots, or other issues?
         2. Does the planned sustainability use for the space conform to or contradict the approved ALP and/or master plan (existing or future)?
      iv. Are there potential conflicts with existing building code and/or zoning requirements?
   c. Economic
      i. Consider locally high electricity costs, fuel costs, etc.
   d. Environmental
      i. Consider attainment status, etc.
   e. Adaptability/Technical Performance
      i. Has the concept/technology been proven to be successful at similar facilities and/or in similar circumstances?
      ii. Would you be the first to implement a certain type or usage of technology? Is that a desired situation?
      iii. What is the adaptability of the concept/technology to change?

CHAPTER 5

Airport Sustainability Assessment Tool

This guidebook contains a CD, the ASAT, which guides the user through the basic framework of a sustainability decision-making process (Figure 3). ASAT offers results for users who are on three different tracks of desired assistance:

Track 1: designed for those who are already considering implementation of a particular sustainability strategy and want to know more about it;

Track 2: designed for those who are searching for ideas of sustainability strategies for potential implementation at their airport; and

Track 3: designed for those who are interested in learning what sustainability initiatives other airports have implemented.

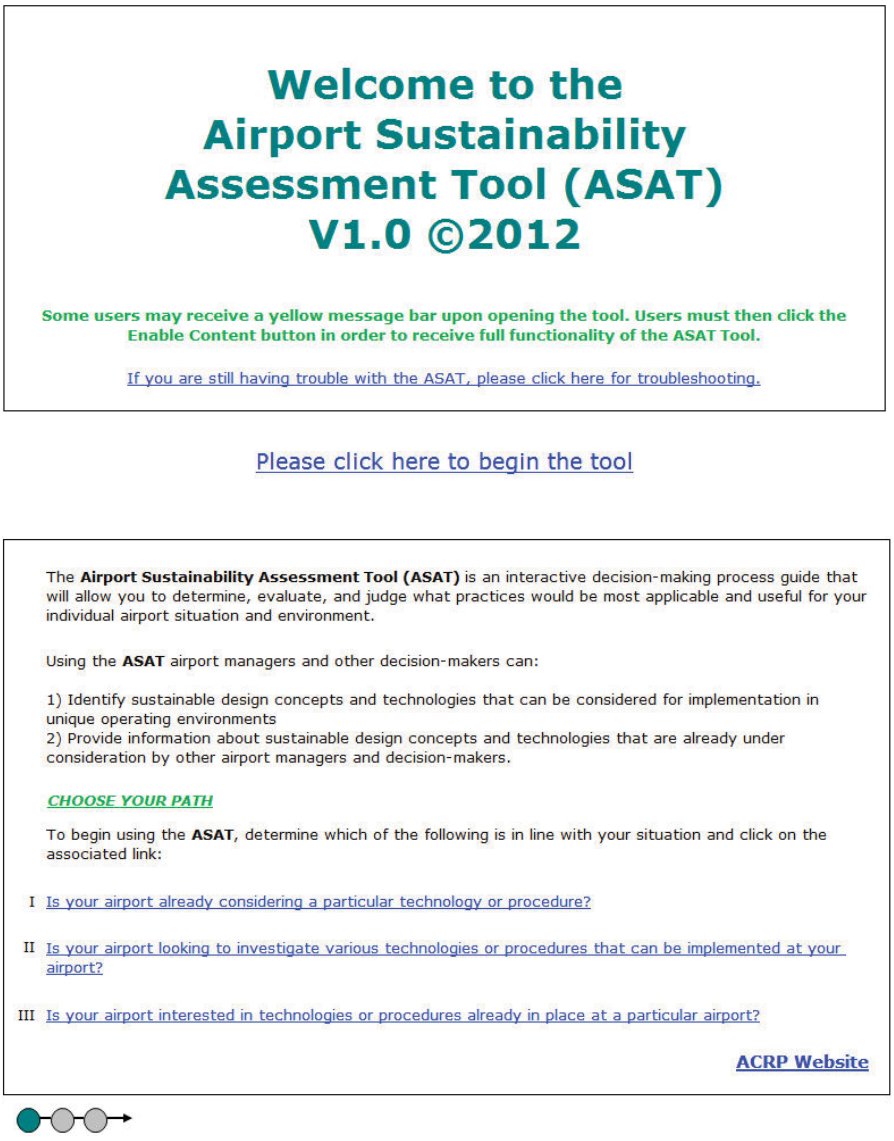

Figure 3. ASAT.

CHAPTER 6

Case Study Summaries

The facilities identified for case study as part of this research represent documented (or documentable) decision-making and evaluation processes, along with quantified, measurable, or anticipated results/benefits of an environmental, financial, and/or social nature. All outcomes were considered to be valuable information to other airports, regardless of whether they were desired, anticipated, unexpected, successful, or unsuccessful. The fact that a facility incorporated a sustainable practice and then has results and "lessons learned" to share with others has deemed it favorable for consideration as a case study.

Airports selected for case study include domestic and international, large and mid-size commercial service airports, and general aviation airports. Non-airport facilities include those with initiatives directly applicable to airports.

Full case study results can be accessed through the accompanying ASAT.

6.1 List of Facilities

The following is an alphabetical list of facilities selected for case study:

Stockholm Arlanda Airport (ARN)
Aspen/Pitkin County Airport (ASE)
Austin-Bergstrom International Airport (AUS)
Chicago Department of Aviation (CDA)
Chicago Department of Transportation (CDOT)
Denver International Airport (DEN)
Dallas/Fort Worth International Airport (DFW)
Fort Lauderdale-Hollywood International Airport (FLL)
Ithaca Tompkins Regional Airport (ITH)
Los Angeles International Airport (LAX)
Oakland International Airport (OAK)
Paulding Northwest Airport (PUJ)
Portland International Jetport (PWM)
Seattle-Tacoma International Airport (SEA)
San Francisco International Airport (SFO)
Weber Academic Center at Judson University (WAC)
Harold Washington Social Security Building (WHS)
Toronto Pearson International Airport (YYZ)

6.2 List of Initiatives

The sustainable initiatives in place at the airports and other facilities selected for case study cover a broad spectrum of practices.

6.2.1 Administrative Items and Procedures

The following case studies include information related to the development, implementation, and incorporation of sustainable initiatives into everyday airport operations and activities related to administrative items and procedures.

- Stockholm Arlanda International Airport
  - Developing an Airport Sustainability Program
- Aspen/Pitkin County Airport
  - Integration of sustainability into Master Plan updates
  - Developing a Sustainability Program
- Austin-Bergstrom International Airport
  - Airport Planning and Construction initiatives
- Chicago Department of Aviation
  - Sustainable Airport Manual
  - LEED Certification
  - Sustainability Evaluation and Recommendation Team (SERT)
- Denver International Airport
  - Sustainability Management Plan
- Dallas/Fort Worth International Airport
  - Sustainability Manager/Success Stories/Message
  - Integration into the Organization
  - Identifying Solutions
- Fort Lauderdale-Hollywood International Airport
  - Green Airport Initiative
  - Sustainability Program
- Ithaca Tompkins Regional Airport
  - Sustainable Master Plan
- Los Angeles International Airport
  - Sustainable Guidelines
  - Sustainability Performance Improvement Management System
- Oakland International Airport
  - LEED Certified Buildings
  - General Environmental Program Activities
- Portland, Maine International Jetport
  - LEED for Buildings
- Seattle-Tacoma International Airport
  - Sustainability Vision
  - Project Analysis/Asset Management
- San Francisco International Airport
  - Sustainable Initiatives
- Toronto Pearson International Airport
  - Environmental Management System and ISO 14001 Certification
  - Sustainability integration including Alternative Energy Analysis and LEED Certification

6.2.2 Sustainable Site Management

The following case studies include information related to the development, implementation, and incorporation of sustainable initiatives into design and construction, as well as everyday airport operations and activities related to sustainable site selection and management.

- Aspen/Pitkin County Airport
  - Integration of Sustainability into Master Plan Updates
  - Sustainable Initiatives incorporated into design/construction of runway extension
- Austin-Bergstrom International Airport
  - Airport Planning and Construction Sustainable Initiatives
- Chicago Department of Aviation
  - Sustainable Airport Manual
  - Vegetated Green Roofs
- Dallas/Fort Worth International Airport
  - Operations and Maintenance Initiatives
  - Water Sense
- Denver International Airport
  - Construction Measures
  - Sustainability Management Plan
- Fort Lauderdale-Hollywood International Airport
  - Green Airport Initiative
  - Operations
  - Sustainability Program
  - Staff Training
- Los Angeles International Airport
  - Construction Mitigation
  - Construction Activity
  - Sustainability Guidelines
  - Operations
  - Water Conservation
- Oakland International Airport
  - General Environmental Program Activities
- Portland, Maine International Jetport
  - LEED for Buildings
- Seattle-Tacoma International Airport
  - Sustainable aviation fuels
- San Francisco International Airport
  - Water Conservation
- Water Harvesting Solutions - Harold Washington Social Security Building
  - Water harvesting
- Toronto Pearson International Airport
  - Environmental Management System
  - Stormwater Management/Central Deicing Facility
  - Integration of Sustainability into Design and Construction

6.2.3 Water Efficiency

The following case studies include information related to the development, implementation, and incorporation of sustainable initiatives into design and construction, as well as everyday airport operations and activities related to water efficiency.

- Aspen/Pitkin County Airport
  - Integration of Sustainability into Master Plan Updates
  - Sustainable Initiatives incorporated into design/construction of runway extension
- Austin-Bergstrom International Airport
  - Central Plant/Chilled Water
  - Airport Planning and Construction Sustainable Initiatives

- Chicago Department of Aviation
  - Sustainable Airport Manual
  - Vegetated Green Roofs
- Dallas/Fort Worth International Airport
  - Water Sense
- Denver International Airport
  - Construction Measures
- Los Angeles International Airport
  - Water Conservation
  - Construction Mitigation
  - Construction Activity
- Paulding Northwest Airport
  - Stormwater Management with Rock Cribs
- San Francisco International Airport
  - Water Conservation
- Water Harvesting Solutions – Harold Washington Social Security Building
  - Water Harvesting
- Toronto Pearson International Airport
  - Stormwater Management
  - Integration of Sustainability into Design and Construction
  - Stormwater Management/Central Deicing Facility

6.2.4 Energy and Atmosphere

The following case studies include information related to the development, implementation, and incorporation of sustainable initiatives into design and construction, as well as everyday airport operations and activities related to energy and atmosphere.

- Stockholm Arlanda International Airport
  - Biogas Production
  - Underground Energy Storage
- Aspen/Pitkin County Airport
  - Energy Smart Resource Center
  - Green Energy Initiatives
  - Integration of Sustainability into Master Plan Updates
  - Sustainable Initiatives incorporated into design/construction of runway extension
- Austin-Bergstrom International Airport
  - Alternative Fuels for Fleet Vehicles
  - Photovoltaic Power
  - Energy efficiency upgrades
  - Airport Planning and Construction Sustainable Initiatives
- Chicago Department of Aviation
  - Energy use reduction
  - Sustainable Airport Manual
- Denver International Airport
  - Solar power
  - Energy and emissions reduction programs
  - Construction measures
- Dallas/Fort Worth International Airport
  - Solar panels
  - Green ITS Initiative
  - Operations and Maintenance Initiatives

- Los Angeles International Airport
  - Air Quality initiatives
  - Energy conservation
  - Construction Mitigation
  - Construction Activity
- Oakland International Airport
  - Energy initiatives
  - Air quality initiatives
- Portland, Maine International Jetport
  - Energy management
  - Geothermal heating/cooling
- Seattle-Tacoma International Airport
  - Sustainable aviation fuels
- San Francisco International Airport
  - Energy use reduction
  - Air quality initiatives
  - Solar array
- Harm A. Weber Academic Center at Judson University
  - Hybrid Natural Ventilation System
- Toronto Pearson International Airport
  - Energy management initiatives
  - Integration of Sustainability into Design and Construction

6.2.5 Materials and Resources

The following case studies include information related to the development, implementation, and incorporation of sustainable initiatives into design and construction, as well as everyday airport operations and activities related to materials and resources.

- Aspen/Pitkin County Airport
  - Integration of Sustainability into Master Plan Updates
  - Sustainable Initiatives incorporated into design/construction of runway extension
- Austin-Bergstrom International Airport
  - Airport Planning and Construction Sustainable Initiatives
  - Solid Waste Management in terminal areas and Department of Aviation buildings
- Chicago Department of Aviation
  - Recycling Initiatives
  - Sustainable Airport Manual
  - Balanced Earthwork
- Denver International Airport
  - Recycling Programs (general)
  - Grease Recycling
  - Composting
  - Sustainable Operations Initiatives
  - Sustainability Management Plan
  - Construction Measures
- Dallas/Fort Worth International Airport
  - Recycling Programs
  - Sustainable Operations and Maintenance Initiatives
- Fort Lauderdale-Hollywood International Airport
  - Sustainable Operations
  - Sustainability Program

- Los Angeles International Airport
  - Recycling Programs
  - Sustainable Guidelines
  - Sustainable Operations
  - Construction Mitigation
  - Construction Activity
- Oakland International Airport
  - General Environmental Program Activities
- San Francisco International Airport
  - Recycling
  - Composting
  - Sustainable Initiatives
- Toronto Pearson International Airport
  - Tenant/Concessionaire Initiatives
  - Integration of Sustainability into Design and Construction

6.2.6 Indoor Environmental Quality

The following case studies include information related to the development, implementation, and incorporation of sustainable initiatives into design and construction, as well as everyday airport operations and activities related to indoor environmental quality.

- Aspen/Pitkin County Airport
  - Developing a Sustainability Program
  - Integration of Sustainability into Master Plan Updates
  - Sustainable Initiatives incorporated into design/construction of runway extension
- Austin-Bergstrom International Airport
  - Airport Planning and Construction Sustainable Initiatives
- Chicago Department of Aviation
  - Sustainable Airport Manual
  - LEED Certification
- Denver International Airport
  - Sustainable Operations Initiatives
  - Sustainability Management Plan
  - Construction Measures
- Dallas/Fort Worth International Airport
  - Sustainable Operations and Maintenance Initiatives
- Fort Lauderdale-Hollywood International Airport
  - Sustainable Operations
  - Sustainability Program
- Los Angeles International Airport
  - Sustainable Guidelines
  - Sustainable Operations
  - Construction Mitigation
  - Construction Activity
- Oakland International Airport
  - LEED Certified Buildings
  - General Environmental Program Activities
- Portland, Maine International Jetport
  - LEED for Buildings
- San Francisco International Airport
  - Sustainable Initiatives

- Harm A. Weber Academic Center at Judson University
  - Hybrid Natural Ventilation System
- Toronto Pearson International Airport
  - Environmental management system and ISO 14001 Certification
  - Integration of Sustainability into Design and Construction

6.2.7 Social Responsibility

The following case studies include information related to the development, implementation, and incorporation of sustainable initiatives into everyday airport operations and activities related to social responsibility.

- Stockholm Arlanda International Airport
  - Developing an Airport Sustainability Program
- Aspen/Pitkin County Airport
  - Developing a Sustainability Program
- Austin-Bergstrom International Airport
  - Social/Cultural Sustainability Initiatives
- Chicago Department of Aviation
  - Sustainable Airport Manual
- Denver International Airport
  - Sustainability Management Plan
  - Social Programs
- Dallas/Fort Worth International Airport
  - Employee Education
  - Integration into the Organization
  - Identifying Solutions
  - Resources Outside of the Aviation Community
  - Contractors
  - Executive Responsibility
  - Live Well Programs
- Fort Lauderdale-Hollywood International Airport
  - Staff Training
  - Sustainability Program
  - Coordination with Broward County
- Los Angeles International Airport
  - Community Benefit Agreement
  - Sustainable Guidelines
  - Sustainability Performance Improvement Management System
  - Environmentally Friendly and Socially Responsible Products
  - Promote Sustainability Awareness
- Oakland International Airport
  - General Environmental Program Activities
- Seattle-Tacoma International Airport
  - Sustainability Vision
- San Francisco International Airport
  - Sustainable Initiatives
  - Concessions Program
  - Contractors
  - T2 Sustainable Initiatives for Concessionaires
- Toronto Pearson International Airport
  - Tenant/Concessionaire Initiatives
  - Partners in Project Green

6.2.8 Sustainable Construction Practices

The following case studies include information related to designing for sustainable use and reuse of materials and resources.

- Aspen/Pitkin County Airport
  - Integration of Sustainability into Master Plan Updates
  - Sustainable Initiatives incorporated into design/construction of runway extension
- Austin-Bergstrom International Airport
  - Airport Planning and Construction Sustainable Initiatives
- Chicago Department of Aviation
  - Sustainable Airport Manual
  - Balanced Earthwork
- Denver International Airport
  - Sustainability Management Plan
  - Construction Measures
- Dallas/Fort Worth International Airport
  - Sustainable Operations and Maintenance Initiatives
- Fort Lauderdale-Hollywood International Airport
  - Sustainable Operations
  - Sustainability Program
- Los Angeles International Airport
  - Sustainable Guidelines
  - Sustainable Operations
  - Construction Mitigation
  - Construction Activity
- San Francisco International Airport
  - Recycling
  - Sustainable Initiatives
- Toronto Pearson International Airport
  - Integration of Sustainability into Design and Construction

APPENDIX A

Glossary of Terms and Definitions

Biodiesel

Biodiesel is a domestic, renewable fuel for diesel engines derived from natural oils like soybean oil. Biodiesel can be used in any concentration with petroleum based diesel fuel in existing diesel engines with little or no modification.

Carbon Dioxide

A naturally occurring gas, carbon dioxide is also a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes. It is the principal anthropogenic greenhouse gas that affects the Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured and therefore has a Global Warming Potential of 1. See climate change and global warming.

Carbon Emissions

Carbon emissions refers to polluting carbon substances released into atmosphere: carbon dioxide and carbon monoxide produced by motor vehicles and industrial processes and forming pollutants in the atmosphere.

Carbon Footprint

A carbon footprint is an estimate of how much carbon dioxide is produced to support your lifestyle. Essentially, it measures your impact on the climate based on how much carbon dioxide you produce. Factors that contribute to your carbon footprint include your travel methods and general home energy usage. Carbon footprints can also be applied on a larger scale to companies, businesses, even countries.

Carbon Offsets

Carbon offsets are used to reduce the amount of carbon that an individual or institution emits into the atmosphere. Carbon offsets work in a financial system where, instead of reducing its own carbon use, a company can comply with emissions caps by purchasing an offset from an independent organization. The organization will then use that money to fund a project that reduces carbon in the atmosphere. An individual can also engage with this system and similarly pay to offset his or her own personal carbon usage instead of, or in addition to, taking direct measures such as driving less or recycling.

Carbon offsets are most often used by companies or institutions to reduce their carbon footprint without actually polluting less. Most offsets involve renewable energy. For example, a company in Massachusetts can pay to build a wind turbine off the coast. By using its money to create renewable energy, that company thereby offsets its own carbon use.

Climate Change

Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from:

- Natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun;
- Natural processes within the climate system (e.g., changes in ocean circulation);
- Human activities that change the atmosphere's composition (e.g., through burning fossil fuels) and the land surface (e.g., deforestation, reforestation, urbanization, desertification, etc.).

Composting

Composting is the controlled biological decomposition of organic material in the presence of air to form a humus-like material. Controlled methods of composting include mechanical mixing and aerating, ventilating the materials by dropping them through a vertical series of aerated chambers, or placing the compost in piles out in the open air and mixing it or turning it periodically.

Energy Star

Energy Star is a program that evaluates the energy efficiency of appliances, house fixtures and other home utilities. Co-sponsored by the U.S. Environmental Protection Agency and the U.S. Department of Energy, the Energy Star program seeks to reduce greenhouse gas emissions by identifying energy efficient appliances, helping Americans save money on utility bills with more energy efficient homes.

Energy Star ratings can be applied to a variety of household appliances, fixtures, and materials, including refrigerators, washers, dryers, lighting fixtures, computers, home electronics, windows, and heating insulation. When replacing an appliance or fixture in your home, look for the Energy Star label on products that are energy efficient and help protect the environment. When building a new home, you can also hire certified contractors who agree to actively build Energy Star-rated homes.

Geothermal Energy

Geothermal energy is electricity generated by harnessing hot water or steam from within the earth.

Global Warming

Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural

and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities. See climate change, greenhouse effect, enhanced greenhouse effect, radiative forcing, troposphere.

Gray Water

Domestic wastewater composed of wash water from kitchen, bathroom, and laundry sinks, tubs, and washers is referred to as gray water.

Greenhouse Effect

The greenhouse effect refers to the trapping and build-up of heat in the atmosphere (troposphere) near the Earth's surface. Some of the heat flowing back toward space from the Earth's surface is absorbed by water vapor, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the Earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase. See greenhouse gas, anthropogenic, climate, global warming.[7]

Greenhouse Gas (GHG)

Any gas that absorbs infrared radiation in the atmosphere is considered a greenhouse gas. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), ozone (O_3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). See carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride.

Ozone (O_3)

Ozone, the triatomic form of oxygen (O_3), is a gaseous atmospheric constituent. In the troposphere, it is created both naturally and by photochemical reactions involving gases resulting from human activities (photochemical smog). In high concentrations, tropospheric ozone can be harmful to a wide range of living organisms. Tropospheric ozone acts as a greenhouse gas. In the stratosphere, ozone is created by the interaction between solar ultraviolet radiation and molecular oxygen (O_2). Stratospheric ozone plays a decisive role in the stratospheric radiative balance. Depletion of stratospheric ozone, due to chemical reactions that may be enhanced by climate change, results in an increased ground-level flux of ultraviolet (UV-) B radiation. See atmosphere, ultraviolet radiation.

Phantom Load

A phantom load is the electricity consumed by an appliance or electrical device when it is not actively being used or is in the "off" mode. Although these devices appear to be off, they continue to draw electricity from outlets to keep their circuits instantly ready for the next time they are turned on. To prevent the draw of phantom loads, unplug any devices that are not in use and do not require power, such as computers, modems, answering machines, fax machines, and printers.

Recycling

Collecting and reprocessing a resource so it can be used again is referred to as recycling. An example is collecting aluminum cans, melting them down, and using the aluminum to make new cans or other aluminum products.

Renewable Energy

The term renewable energy generally refers to electricity supplied from renewable energy sources, such as wind and solar power, geothermal, hydropower, and various forms of biomass. These energy sources are considered renewable sources because they are continuously replenished on the Earth.

Solar Panels

Solar panels are a type of photovoltaic (PV) system that collects energy from sunlight and converts it into usable energy for a building. Also called photovoltaic (PV) cells, solar panels typically contain no corrosive chemicals, do not pollute, and require little maintenance. During daylight hours, PV panels produce energy that is fed back into the electrical grid or stored for future use.

Solar Radiation

Solar radiation is radiation emitted by the sun. It is also referred to as short-wave radiation. Solar radiation has a distinctive range of wavelengths (spectrum) determined by the temperature of the sun. See ultraviolet radiation, infrared radiation, radiation.

Sustainable

Meeting the needs of the present without diminishing the ability of future generations to meet their needs is the definition of sustainability. Sustainability also means that human practices do not result in the permanent damage, alteration or depletion of the environment, ecosystems, species or natural resources.

Wind Energy

Wind energy is energy collected from motion caused by heavy winds. Wind energy is collected in turbines with propellers that spin when the wind blows and turn the motion of the propeller into energy that can be used in the electrical grid. Wind energy is a clean, renewable energy source that is abundant in windy areas. Large wind farms are often located outside of cities, supplying power for electrical grids within the city.

Glossary Source: *U.S. Environmental Protection Agency (December 1997) Terms of Environment: Glossary, Abbreviations and Acronyms. Washington, D.C. Available on-line at: http://www.epa.gov/OCEPAterms*

APPENDIX B

Sustainable Initiatives for Incorporation Into Traditional Airport Projects

As a result of the research and case studies conducted, the following sections describe detailed sustainable strategies for airports to incorporate into traditional airport projects, including:

B.1 Administrative Procedures

The goal of sustainable administrative items and procedures is to promote workplace practices, procedures, and material use that provide the reduction of energy, water, and materials. The intention is to not only plan, design, construct, maintain, and operate an airport in a sustainable manner, but to raise awareness that sustainability is also integrated into the process of administering these activities. Sustainable initiatives for consideration at an airport that are related to administrative items and procedures include, but are not limited to those listed below.

- Develop an Organizational Sustainability Policy and Sustainability Vision Statements
    - Establish and adopt an overall Organizational Sustainability Policy and/or a project-specific Sustainability Vision Statement that focus on the role and impact of your organization in the workplace, marketplace, environment, and community. Use the policy and vision statement to

outline and guide the preferred approach to sustainability initiatives for the entire organization and project-by-project.
    - Provide an electronic copy of the Policy to all employees and contractors.

- Develop a Green Procurement Policy
    - The intent is to reduce the environmental impact of products and services by developing and implementing a Green Purchasing Program, which can be accomplished by:
        - Introducing environmentally conscious purchasing into organizational practices.
        - Clearly defining objectives.
        - Establishing a sustainability-claims verification procedure that can be replicated as necessary.
        - Evaluating items that are purchased and identifying more environmentally friendly alternatives, along with establishing a policy to purchase these alternatives when economically feasible. This might also require working with suppliers to identify sustainable products that meet your organization's needs
        - The following resources can be used to create a Procurement Policy. Resources include but are not limited to:
            - U.S. EPA's Environmentally Preferable Purchasing (EPP) Program guidelines: www.epa.gov/epp.
            - U.S. EPA's Comprehensive Procurement Guidelines (CPG) includes an index of products and their recommended recycled content: www.epa.gov/epawaste/conserve/tools/cpg/products/index.htm.
            - U.S. EPA's Water Sense program promotes water efficiency and enhances the market for water-efficient products, programs and practices: www.epa.gov/WaterSense/.
            - DOE's Alternative Fuels and Advanced Vehicles Data Center provides a wide range of information and resources to enable the use of alternative fuels, as well as other options to reduce petroleum use, including advanced vehicles, fuel blends, idle reduction, and fuel economy: www.afdc.energy.gov/afdc/.
            - Fair Trade Products purchased in place of regular products builds equitable and sustainable trading partnerships: www.fairtradefederation.org.
            - USDA's BioPreferred Designated Products Program is designed to increase the purchase and use of renewable, environmentally friendly bio-based products, while promoting a green marketplace: www.catalog.biopreferred.gov/bioPreferredCatalog/faces/jsp/catalogLanding.jsp.

- Conduct Green Meetings
    - Establish and implement Green Meeting Practices, which are intended to guide meeting hosts, planners, and attendees toward more eco-friendly meetings. Strategies include, but are not limited to:
        - Reduce the number of copies of meeting materials by asking participants to share meeting materials; digitize materials and distribute presentations via email prior to the meeting, place/project materials on the wall (one large print or presented with projector equipment).
        - If handouts are needed at the meeting, produce handouts locally, double-sided, high post-consumer recycled content paper/chlorine-free paper, vegetable-based inks, black and white or grayscale, print in draft mode (uses less ink).
        - Recycle or save for future reuse, all materials following the meeting.
        - Allow participants who would travel to/from the meeting to participate via phone or internet instead.
        - If travel cannot be avoided, encourage carpool or public transportation.

- Develop a Document Reduction Recycling Initiative (DRRI)
    - The intents are to reduce the volume of paper used and to facilitate document recycling.
        - Identify and issue only essential paper copies.
        - Designate centralized review rooms for documents and drawings to eliminate the need for multiple paper copies.
        - Encourage recycling of all documents by asking reviewers to return obsolete documents for recycling.

- Prepare a sustainability baseline assessment, including carbon footprint, or cost/benefit analysis.
    - Perform a preliminary sustainability baseline assessment to represent a "no-project" scenario for comparison purposes.
    - Perform a preliminary cost/benefit analysis for the "with project" scenario in order to determine whether the project appropriately balances the environmental, social, and financial impacts of the project
        - Note: See Guidebook, Section 4.2.

- Encourage LEED Certification for new and existing buildings.
    - LEED (Leadership in Energy and Environmental Design) Certification, administered by the U.S. Green Building Council (USGBC), provides building owners and operators with a framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions. LEED promotes sustainable building and development practices through a suite of rating systems that recognize projects that implement strategies for better environmental and health performance.

B.2 Social Responsibility

The goal of sustainable initiatives regarding social responsibility is to promote awareness among staff, passengers, and the general public of airport and tenant environmental, social, and sustainability initiatives and results. Sustainable initiatives for consideration at an airport that are related to social responsibility include, but are not limited to those listed below.

- Staff Education and Training Programs
    - Staff includes airport employees, contractors, consultants, concessionaires, tenants, and all others with active airport contracts.
    - Develop and implement an Employee Sustainability Training Program for existing employees, and new employees as hires occur, to cover a variety of topics designed to provide a consistent and overall understanding of the airport's sustainability commitments and how each employee can contribute to meeting those goals and targets.
    - Training should include, but is not limited to the following major topics:
        - Organizational sustainability policy
        - Project sustainability vision statements
        - Key targets and goals
        - Process for evaluation and improvement
        - Computer based systems and software
        - Facilitates monitoring, tracking, and reporting
        - Water management plan/waste reduction goals
        - Storage and collection of recyclables
        - Composting or re-use options
        - Managing and disposing of waste
        - Systems management, including HVAC and other complex components
        - Emissions reduction strategies
        - Alternative fuel usage

- Passenger/Community Education Programs
    - Provide and promote education through the following means that include, but are not limited to:
        - Flyers
        - Pamphlets
        - Press Releases
        - Signage
        - Interactive and static kiosks
        - Workshops
        - Conferences
        - Website
        - Email updates
        - Public exhibits
    - Solicit suggestions from passengers and tenants on how to improve the airport's environmental, social, and sustainability programs

- Documenting Sustainable Initiatives
    - Track, document, report and promote the airport's commitment to sustainability and encourage divisions and tenants airport-wide to join in your efforts.
    - By division and/or project:
        - Identify a primary contact person for all sustainability-related tracking and communications.
        - Document overall operating costs (i.e., water/electricity/recycle) for the previous five years (or length of building occupancy, whichever is shorter) and track changes in overall building operating costs over the performance period. Document operating costs and financial impacts of all aspects of implementation of sustainable initiatives on an ongoing basis.
        - Track operating costs to identify any positive impacts related to sustainable performance improvements to a building and its operations. At a minimum include water, electricity, and waste management data to document operating costs on an ongoing basis. Use this data to optimize consumption and waste from operations and identify potential areas of improvement in future performance periods

B.3 Planning Process

The intent of a sustainable planning process is to integrate sustainability considerations and goals into the planning process for all projects' design, implementation, and operational stages, regardless of size and scope.

Major elements of a sustainable planning process include, but are not limited to:

- Determine key stakeholders and hold initial project meeting to discuss sustainability goals of the project.
- Conduct sustainability baseline assessment and cost/benefit analysis.
- Develop a sustainability schematic to guide how sustainability goals are to be met throughout the project
- Hold a project meeting with key stakeholders to finalize sustainability schematic.
- Gather feedback at project completion by holding a meeting with key stakeholders to identify successes, opportunities for improvement, and lessons learned.

B.4 Sustainable Site Management

Sustainable initiatives for consideration at an airport that are related to sustainable site management include, but are not limited to those listed below. These initiatives can be incorporated into everyday airport operations and activities.

- Equipment Maintenance
    - Minimize the environmental impact of maintenance equipment and associated maintenance activities by establishing Best Management Practices (BMPs) outlining procedures for vehicle washing, maintenance, fueling, chemical storage, and spill control.

- Exterior Facilities Management
    - Encourage environmentally sensitive building exterior practices by developing and implementing an environmentally sensitive, low-impact building/facility exterior plan, designed to discourage surrounding wildlife habitat, while sustaining ecological and environmental integrity. The plan should employ BMPs that significantly reduce harmful chemical use, energy waste, water waste, air pollution, solid waste, and/or chemical runoff (e.g., gasoline, oil, antifreeze, salts) compared with standard practices. The plan should also address operational elements that occur on the building and grounds, as applicable, such as cleaning of building exterior and paints and sealants used on the building exterior.

- Hardscape Grounds Management as related to snow and ice removal and anti-ice/deice applications
    - Use environmentally sensitive, low-impact snow and ice removal methods that utilize innovative and ecologically friendly chemicals and/or employ BMPs that significantly reduce harmful chemical use, thereby reducing energy waste, water waste, air pollution, solid waste, and/or chemical runoff (e.g., gasoline, oil, antifreeze, salts).
        - Airside ground anti-icing/deicing materials that are environmentally friendly, include, but are not limited to:
            - Solid: sodium formate and sodium acetate, and
            - Liquid: potassium acetate.
    - Develop a landside policy for minimizing road salt usage balancing environmental and safety concerns.
        - Examine alternative products and methods, such as beet juice, brine, and similar.
    - Investigate non-electrified snowmelt procedures, including hydronic runway pavement for snowmelt and epoxy overcoat with glycol for controlling snow on runways.
    - Use fossil fueled equipment only as frequently as needed to maintain site appearance and safety, or use low-impact alternatives such as, but not limited to:
        - Electric powered equipment
        - Low-noise equipment

        - Hand raking or sweeping
    - Use more environmentally friendly deicing chemicals, such as but not limited to:
        - Magnesium chloride
            - Potassium chloride
            - Potassium acetate
        - Administer eco-training, such as chemical use and eco-driving to personnel to ensure appropriate use/applications, and to reduce fuel consumption, greenhouse gas emissions, and accident rate.
    - Consider use of the following innovations:
        - Infrared radiant deicing technology
        - Forced air/hybrid deicing which adds deicing fluid to the airstream to aid in removing ice and snow
        - Tempered steam technology

- Integrated Pest Management and Wildlife Deterrence
    - In an effort to preserve environmental integrity, while discouraging the presence of pests/wildlife, implement methods that use Integrated Pest Management (IPM) Techniques, such as:
        - Control dirt, moisture, clutter, foodstuffs, harborage, and building penetrations
        - Use baits and traps rather than pesticide sprays where possible
        - Avoid pesticide applications for prevention of pests
        - Use pesticides only where pests are located
        - Use pesticide specifically formulated for targeted pest
        - Use wildlife deterrent methods in accordance with U.S. Department of Agriculture - Wildlife Services
    - In addition, it is recommended that the following BMPs be put in place:
        - Apply pesticides only during unoccupied hours.
        - Ventilate building with significant quantities of outside air during and after applications.
        - Completely flush building prior to occupancy.
        - Use more than normal outside air ventilation for some period after occupancy.
        - Notify occupants prior to occupation.
        - If applying outside keep away from air intake.
        - Administer eco-training, such as chemical use, eco-driving, to personnel to ensure appropriate use/applications, and to reduce fuel consumption, greenhouse gas emissions, and accident rates.

- Erosion Control
    - Develop and implement a maintenance plan and BMPs that address overall site management and control. Examples of such methods include, but are not limited to:
        - Mulching
        - Structural control methods, such as earthen dike, silt fence, sediment traps, and sediment basins
        - Buffer strips

        - Ditch liners
        - Limit the use of fertilizer, as necessary
        - Removing and/or not installing invasive plants
        - Identify problems
        - Perform periodic checks
        - Dispose of loose debris
        - Maintain ground cover
        - Clean major sediment sources on paved surfaces
        - Install rolled mats (organic, biodegradable mulch mats used to reduce erosion) and ensure that they conform to site contours
        - Use natural fiber geotextiles (permeable fabrics) that are biodegradable
        - Install permeable paving materials to reduce stormwater runoff and allow rain water to infiltrate into the ground and replenish groundwater
        - Create contractual requirement specifications to inspect, maintain, and replace the erosion control measures

- Landscape Management
    - Have in place a low-impact plan that addresses overall site management, chemicals, fertilizers, and landscape waste, including green landscape management practices such as the following:
        - Provide proper training methods to current employees.
        - Reduction of the use of power equipment.
        - Discourage wildlife habitat.
        - Remove or do not install invasive plants.
        - Use mulching mowers to significantly reduce landscape waste generation, fertilizer needs, and water consumption through retention of organic matter.
    - Do not apply pesticides or fertilizers before an expected rainfall, unless specified within the manufacturers recommendations.
    - Conduct soil testing, as necessary, to determine the amount of nutrients needed for a healthy landscape.
    - Do not wash spilled chemicals into streets of storm drains.
    - Do not store chemicals in a manner that allows exposure to storm water.
    - Do not apply chemicals within 25-feet (at a minimum) of a body of water.
    - Use organic and natural products.
    - Use non-potable hot water for weed control to eliminate vegetation in pavement cracks in place of herbicides.
    - Use mulching and/or electric mowers.
    - Eliminate fertilizer and herbicide use completely or to the greatest extent possible.
    - Install rolled organic, biodegradable mulch mats used to reduce erosion, and ensure that they conform to site contours.
    - Use natural fiber geotextiles/permeable fabrics that are biodegradable.

- Specify non-toxic, non-chemical organic or bio-based materials for landscape planting and fertilization.
- Top-dress soil with compost to decrease fertilizer and irrigation needs, to control erosion, and to retain moisture.
- When applying landscape fertilizers, pesticides, and other chemicals as necessary, specify organic or bio-based fertilizers and pesticides.
- Spot treat landscape problem areas instead of chemically treating a larger area than necessary.
- Use electric lawn mowers to reduce the level of noise and air pollution generated by traditional gasoline-powered mowers. Electric mowers need no extension cords and have replaceable, rechargeable batteries for extended range.
- Use propane and/or natural gas-powered string trimmers, blowers, and push mowers.
- Specify that all diesel-powered equipment are to use biodiesel with a minimum 20% blend.
- Do not allow mowing on Air Pollution Action days, as appropriate.
- Install cisterns and other water recycling infrastructure to use stormwater and/or gray water for irrigation.
- Install high-efficiency irrigation systems (if irrigation is a necessity) with a slow-drip, sub-soil irrigation and automated linkages to meteorological data.
- Administer eco-training, such as chemical use, eco-driving, to personnel to ensure appropriate use/applications, and to reduce fuel consumption, greenhouse gas emissions, and accident rates.
- Consider use of the following innovations:
  - Establish a centralized landscaping composting facility.
  - Utilize a solar or propane mower.

- Stormwater Management
  - Landside:
    - Replace impervious surfaces with permeable surfaces, including, but not limited to:
      - Permeable asphalt/concrete
      - Open grid pavers
      - Aggregate materials
      - Turf or landscaped area
    - Harvest rainwater and develop a use for it, such as landscape irrigation.
    - Install rain gardens, vegetated swales, disconnection of imperviousness, and rainwater recycling.
    - Install cisterns or rain barrels.
    - Install landscaping to reduce runoff.
    - Evaluate curb breaks and drainage ditches, and/or bioswales
    - Install high-efficiency irrigation systems (if irrigation is a necessity) with a slow-drip, sub-soil irrigation.

        - Install permeable paving materials to reduce stormwater runoff and allow rain water to infiltrate into the ground and replenish groundwater.

    - Airside:
        - Use sweeper vacuums, glycol recovery vehicles, and/or mobile collection units to remove and reuse spent deicing fluid.
            - Recover and recycle deicing chemicals at application point (e.g., vacuum truck, or other capturing method).
        - Develop collection systems for deicing runoff. The proposed runway and taxiway pavements would contain first flush systems along the edge of pavements and central deicing facilities for aircraft. The first flush system could consist of slotted edge drains connected to underground holding tanks. Glycol contaminated snowmelt and minor storm water runoff would be captured in the tanks and removed for treatment, disposal or recycling.
        - Reduce or eliminate deicing chemical contamination by using low Biological Oxygen Demand (BOD), low toxicity, and low corrosivity material (e.g., acetate).
        - Incorporate technologies, application techniques and/or designs to minimize glycol residual after application of deicing agents
        - Use glycol separation and/or concentration methods to recover spent glycol from storm water or snow melt.
        - Consider development of a Central Deicing Facility to capture and dispose of excess glycol from aircraft deicing operations in underground storage tanks.

- Water Quality
    - Sustainable practices for protecting water quality provide benefits of water conservation and reduced water pollution through minimization of impacts from flooding and stormwater runoff. The following sustainable practices serve to improve water quality and control stormwater runoff with a list of best management practices that exemplify green and sustainable technologies:

        - Complete a low-impact development (LID) hydrologic analysis for use in project decision making for stormwater management. LID describes engineered controls, stormwater management facilities, and other land development BMPs that attempt to mimic pre-development hydrologic conditions by emphasizing infiltration, evapotranspiration, or stormwater reuse for long-term flow control and runoff treatment.

          An example for conducting an LID analysis includes, but is not limited to the following:

          USDA Soil Conservation Service (SCS) TR-55: Urban Hydrology for Small Watersheds: http://www.hydrocad.net/tr-55.htm

- Develop a site drainage design report that includes, at minimum, the following:
    - Statement of initial and design conditions for flow rate, time of concentration and runoff volume.
    - Supporting calculations for runoff areas, flow rate, times of concentration, and runoff volumes.
    - List of BMPs and their expected flow control performance criteria, such as:
        - Stormwater detention/retention facilities, including catch basins, rain gardens, sand filters, and sediment traps and forebays.
        - Infiltration basin or trench allowing stormwater to filter/drain through the bottom of the basin or trench.
        - Permeable and porous pavements in mostly non- or low-traffic areas, e.g., parking areas, roadway shoulders, maintenance roads, etc.
        - Vegetative swale/bio-swale – a stormwater conveyance system that effectively removes water contaminants prior to reaching surface or ground waters.
        - Bioretention - a low lying area either natural or manmade that is heavily vegetated for the purpose of retaining stormwater and naturally treating pollutant content.
        - Vegetative filter strips – a narrow strip of vegetation usually adjacent to an imperious runoff area that attenuates flows prior to reaching manmade or natural drainage ways.
        - Construction of wetlands to double as a naturalized stormwater detention area(s).
        - Develop policy to reduce or optimize the use of pavement deicers.
- Stormwater cost analysis
    - Determine lifecycle costs and savings associated with low impact development techniques and best management practices for stormwater utilities.
    - The results must show, at minimum, that these criteria have been addressed: 1) expected service life, 2) construction costs, 3) maintenance costs, 4) interest rate, 5) salvage value, and 6) estimated annual cost of the stormwater management system.
- Design site vegetation
    - Include vegetation types that do not need irrigation, to the greatest extent possible.

- Where necessary, consider opportunities for rainwater harvesting through use of above ground or below ground storage systems with latter use for irrigation.
- Incorporate vegetated green roofs on facilities, wherever possible.
- Use only native, non-invasive plant species.
- Maintain and/or enhance natural features, such as wetlands, riparian areas, floodplains, woodlands, etc., to the greatest extent possible.
- Maintain and/or enhance riparian and forested buffers wherever possible so as not to adversely affect natural attenuation of runoff to streams, ponds and wetlands.

- Central Deicing Facility
  - Consider development of a central deicing facility to capture excess glycol from aircraft deicing operations in underground storage tanks.

- Heat Island Reduction, including Green/Vegetated Roofs, White Roofs, or similar
  - Minimize impacts of existing roofs and pavements that cause the heat island effect, which is caused by thermal gradient differences between developed and undeveloped areas.
    - Provide shade from an existing tree canopy or within five years of landscape installation.
    - Use paving materials with a Solar Reflective Index (SRI) of at least 29 and implement a maintenance program that ensures these surfaces are cleaned at least every two years to maintain good reflectance and minimums.

      Note: SRI is calculated according to ASTM E 1980. Reflectance is measured according to ASTM E 903, ASTM E 1918 or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371. Product information is available from the Cool Roof Rating Council website, at www.coolroofs.org. Also, visit the ENERGY STAR website, www.energystar.gov to research compliant products.

    - Use an open-grid pavement system (that consists of at least 50% open area).
    - Install a vegetated green roof atop occupied or unoccupied structures.
    - Employ strategies, materials and landscaping techniques that reduce heat absorption of exterior materials.
      - Use shade (calculated at 10 a.m., 12 noon, and 3 p.m. on the summer solstice [June 21] that will be used as the effective shaded area) from native or adapted trees and large shrubs, vegetated trellises or other exterior structures supporting vegetation.

        - Vegetation is recommended for landside projects only and should not attract wildlife.
    - Consider the use of new coatings and integral colorants for asphalt to achieve light-colored surfaces instead of blacktop.
    - Position photovoltaic cells to shade impervious surfaces.
    - Consider installing high-albedo roofs to reduce heat absorption.
    - Install open grid pavement for surface lots and site pavement.
    - Install light-colored permeable pavers and concrete.
    - Install "green walls" or "living walls" for building façade.

- Light Pollution Reduction
    - Eliminate light trespass from building interiors and outdoor areas, thereby improving night sky access and reducing development impact on nocturnal environments.
    - For interior lighting
        - Automatically control all non-emergency built-in interior/indoor lighting to turn off during all after-hours periods.
        - Implement a program to ensure that the lighting control system is being properly used to adjust lighting levels during all after-hours periods.
    - For exterior lighting
        - Partially or fully shield all fixtures so that they do not directly emit light to the night sky.

- Alternative Commuting Transportation for Employees
    - To reduce pollution and land development impacts from conventional automobile use for commuting trips. Alternative transportation includes, but is not limited to:
        - Telecommuting
        - Compressed work weeks
        - Mass/public transit
        - Walking
        - Bicycles or other human-powered conveyances
        - Carpools
        - Vanpools
        - Low-emitting, fuel-efficient or alternative-fuel vehicles

B.5 Site Selection and Management

Sustainable initiatives for consideration at an airport that are related to site selection and management include, but are not limited to those listed below. These initiatives can be incorporated into airport design and construction activities.

- Construction Activity Pollution Prevention

  - Create and implement an Erosion and Sedimentation Control (ESC) Plan for all construction activities to describe the measures to be implemented to accomplish the following objectives:
    - Prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
    - Prevent sedimentation of storm sewer or receiving streams.
    - Prevent pollution of the air with dust and particulate matter using BMPs.
  - Incorporate temporary sedimentation basins, temporary ditch checks, diversion dikes, temporary ditches, pipe slope drains into the construction plans.
  - Orient buildings to be able to integrate passive and active solar strategies. If renovating/retrofitting an existing structure (i.e., when employing passive solar strategies is not possible), consider planting trees to shade areas of the building that get more sunshine.
  - For dust control: tarp truckloads, sweep streets as needed, stabilize construction entrances, spray site as necessary to minimize fugitive dust.
  - Establish temporary and permanent seeding plans consistent with direction received by an FAA certified airport biologist to ensure the plants will not attract wildlife.
  - Monitor water quality impacts before and during construction.
  - Develop an inventory of topsoil for potential re-use.
  - Develop a policy to chip or compost all vegetation for re-use on site.

- Good Housekeeping and Best Management Practices
  - The intent is to minimize the environmental impacts of facility operations.
  - Establish BMPs in the form of procedures, activities, or structural controls concerning general good housekeeping activities and pollution prevention for all airport entities.
  - Require project owners, tenants, or ultimate building occupants through tenant or lease agreements, to incorporate into design and construction activities.

- Brownfield Redevelopment
  - The intent is to rehabilitate damaged sites where development is complicated by environmental contamination, thereby reducing pressure on undeveloped land.
  - Brownfields are sites documented as contaminated by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local Voluntary Cleanup Program or are defined as such by a local, state, or federal government agency.
  - During the site selection process, give preference to brownfield sites.
    - Identify tax incentives and property cost savings.
    - Coordinate site development plans with remediation activity, as appropriate.

  - Develop and implement a site remediation plan using strategies outlined by local, state, or federal government agencies.
    - Cleanup requirements will be dependent on site conditions, applicable remediation standards, and timing requirements.

- Alternative Transportation
  - To reduce pollution and land development impacts from conventional automobile use for construction staff commuting trips, select a site that allows for:
    - Public transportation access
    - Bicycle access, storage and changing rooms
    - Right sized parking capacity
  - Encourage the use of alternative transportation, which includes, but is not limited to:
    - Telecommuting
    - Mass/public transit
    - Walking
    - Bicycles or other human-powered conveyances
    - Carpools
    - Vanpools
    - Low-emitting, fuel-efficient or alternative-fuel vehicles

- Stormwater Design
  - Quantity Control
    - Limit disruption of natural water hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff, and eliminating contaminants.
    - Install vegetated green roofs.
    - Install pervious pavements for roadways, shoulders, non-traffic pavements, maintenance roads, utility yards, airside and landside parking facilities, and pedestrian areas.
    - Install landscape to reduce runoff.
    - Evaluate curb breaks and drainage ditches, and/or bioswales.
    - Encourage installation of systems that are flexible to allow use of gray water.
    - Use rainwater cisterns for landside irrigation during the plant growth season.
  - Quality Control
    - Limit disruption and pollution of natural water flows by managing stormwater runoff.
    - Develop and implement a stormwater management plan that reduces impervious cover, promotes infiltration, and captures and treats stormwater runoff.
    - Install alternative surfaces, such as vegetated green roofs, pervious pavement, or grid pavers to reduce imperviousness and promote infiltration thereby reducing pollutant loadings.

- Install non-structural techniques, such as rain gardens, vegetated swales, disconnection of imperviousness, or rainwater recycling to reduce imperviousness and promote infiltration thereby reducing pollutant loadings.
- Use sustainable design strategies, such as low impact development or environmentally sensitive design to design integrated natural and mechanical treatment systems such as constructed wetlands, vegetated filters, and open channels to treat stormwater runoff.
- Develop collection systems for deicing runoff.
- Incorporate technologies, application techniques and/or designs to minimize glycol residual after application of deicing agents
- Consider installation of a central deicing facility, which could also be utilized to capture excess glycol from aircraft deicing operations in underground storage tanks.

- Heat Island Reduction, including Green/Vegetated Roofs, White Roofs, or similar
    - Minimize impacts of existing roofs and pavements that cause the heat island effect, which is caused by thermal gradient differences between developed and undeveloped areas.
        - Provide shade from an existing tree canopy or within five years of landscape installation.
        - Use paving materials with a SRI of at least 29 and implement a maintenance program that ensures these surfaces are cleaned at least every two years to maintain good reflectance and minimums

            Note: SRI is calculated according to ASTM E 1980. Reflectance is measured according to ASTM E 903, ASTM E 1918 or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371. Product information is available from the Cool Roof Rating Council website, at www.coolroofs.org. Also, visit the ENERGY STAR website, www.energystar.gov to research compliant products.

        - Use an open-grid pavement system (that consists of at least 50% open area)
        - Install a vegetated green roof atop occupied or unoccupied structures.
        - Employ strategies, materials, and landscaping techniques that reduce heat absorption of exterior materials.
            - Use shade (calculated at 10 a.m., 12 noon, and 3 p.m. on the summer solstice [June 21] that will be used as the effective shaded area) from native or adapted trees and large shrubs, vegetated trellises or other exterior structures supporting vegetation.

    - Vegetation is recommended for landside projects only and should not attract wildlife.
  - Consider the use of new coatings and integral colorants for asphalt to achieve light-colored surfaces instead of blacktop.
  - Position photovoltaic cells to shade impervious surfaces.
  - Consider installing high-albedo roofs to reduce heat absorption.
  - Install open grid pavement for surface lots and site pavement.
  - Install light-colored permeable pavers and concrete
  - Install "green walls" or "living walls" for building façade.

- Light Pollution Reduction
  - Eliminate light trespass from building interiors and outdoor areas, thereby improving night sky access and reducing development impact on nocturnal environments.
  - For interior lighting
    - Automatically control all non-emergency built-in interior/indoor lighting to turn off during all after-hours periods.
    - Implement a program to ensure that the lighting control system is being properly used to adjust lighting levels during all after-hours periods.
  - For exterior lighting
    - Partially or fully shield all fixtures so that they do not directly emit light to the night sky.

B.6 Water Efficiency

Sustainable initiatives for consideration at an airport that are related to water efficiency include, but are not limited to those listed below. These initiatives can be incorporated into everyday airport operations and activities.

The goal of developing sustainable initiatives related to increased water efficiency is to reduce the burden on local municipal water supply and wastewater systems.

- Establish a water baseline by tracking water usage for one full year.
  - Use this baseline to establish goals and targets to increase indoor and outdoor water efficiency, thereby reducing future water use.

- Initiatives to increase indoor water efficiency include, but are not limited to
  - Upgrade to high-efficiency fixtures and valves.
  - Utilize fixtures such as dual flush toilets and waterless urinals to reduce wastewater volumes.
  - Evaluate reusing stormwater for non-potable uses.
  - Use local generation of domestic hot water, as much as possible, to eliminate long piping runs associated with recirculation piping unless connecting to an existing hot water recirculating system.

- Increase Outdoor Water Efficiency
    - Landscaping
        - Remove or do not install irrigation systems.
        - Install drought tolerant plants.
        - Utilize native and/or low maintenance vegetation that does not require excessive watering.
        - Minimize use of high maintenance grass areas, lawns and annual plants.
        - Establish areas of high and low landscape maintenance areas.
            - Group plants with similar water-use needs by determining those areas of the site that should receive a higher level of care than others and, during drought periods, more irrigation. Lower maintenance areas should be located on low traffic areas, buffer zones and service areas.
        - If an irrigation system is installed:
            - Also install a soil moisture monitoring system to reduce reliance on timed devices (so as not to water during natural rain events) and to detect system leaks.
            - Incorporate the use of recycled and treated wastewater for the use of irrigation.
            - Evaluate use of gray water cisterns for capturing runoff from roofs, vehicle washing, aircraft washing, and/or irrigation for reuse.
        - Rain Harvesting: Evaluate use of stormwater cisterns for capturing natural rainwater for reuse.

- Innovative Wastewater Management
    - Reduce wastewater generation and potable water demand in order to increase local aquifer recharge. This can be accomplished through implementation of a system or technology that:
        - Reduces potable water use for building sewage conveyance through the use of water conserving fixtures, such as water closets, urinals.
            - Specify high-efficiency fixtures and fittings and dry fixtures, such as composting toilet systems and non-water using urinals to reduce wastewater volumes.
        - Increases available amounts of non-potable water, such as captured rainwater, recycled gray water, and on-site or municipally treated wastewater.
            - Consider reusing stormwater or gray water for sewage conveyance or on-site mechanical and/or natural wastewater treatment systems.
            - Options for on-site wastewater treatment include packaged biological nutrient removal systems and high-efficiency filtration systems.

The goal of designing and constructing projects with water efficiency in mind is to reduce the burden on local municipal water supply and wastewater systems. Sustainable initiatives for consideration at an airport that are related to water efficiency design include, but are not limited to those listed below. These initiatives can be incorporated into airport design and construction activities.

- Water Use Reduction in Buildings
  - Use high-efficiency fixtures and valves.
  - Utilize fixtures such as dual flush toilets and waterless urinals to reduce wastewater volumes.
  - Evaluate reusing stormwater for non-potable uses.
  - Use local generation of domestic hot water, as much as possible, to eliminate long piping runs associated with recirculation piping unless connecting to an existing hot water recirculating system
  - Install dry fixtures such as composting toilets and waterless urinals to reduce wastewater volumes.
  - Use instantaneous hot water heating systems (i.e., tank-less, on-demand hot water heating).
  - Use zones or sub-meters to measure and audit water consumption rates at points of use.
  - Use reclaimed water for cooling tower makeup.
  - Evaluate pulsed-power electromagnetic water treatment, ultraviolet treatment, or ozone treatment for cooling tower water.
  - Establish a water supply system that supports vehicle maintenance without the use of potable water by using recycled water or diverted stormwater for vehicle and aircraft washing.

- Water Efficient Landscaping
  - Do not plan for or install irrigation systems.
  - Install drought tolerant plants.
  - Utilize native and/or low maintenance vegetation that does not require excessive watering.
  - Minimize use of high maintenance grass areas, lawns and annual plants.
  - Establish areas of high and low landscape maintenance areas.
    - Group plants with similar water-use needs by determining those areas of the site that should receive a higher level of care than others and, during drought periods, more irrigation. Lower maintenance areas should be located on low traffic areas, buffer zones and service areas.
  - Rain harvesting: evaluate use of stormwater cisterns for capturing natural rainwater for reuse.

- Innovative Wastewater Technologies
  - Reduce wastewater generation and potable water demand in order to increase local aquifer recharge. This can be accomplished through implementation of a system or technology that:
    - Reduces potable water use for building sewage conveyance through the use of water conserving fixtures, such as water closets, urinals.

        - Specify high-efficiency fixtures and fittings and dry fixtures, such as composting toilet systems and non-water using urinals to reduce wastewater volumes.
    - Increase available amounts of non-potable water, such as captured rainwater, recycled gray water, and on-site or municipally treated wastewater.
        - Consider reusing stormwater or gray water for sewage conveyance or on-site mechanical and/or natural wastewater treatment systems.
        - Options for on-site wastewater treatment include packaged biological nutrient removal systems and high-efficiency filtration systems.

B.7 Energy and Atmosphere

Sustainable initiatives for consideration at an airport that are related to energy and atmosphere include, but are not limited to those listed below. These initiatives can be incorporated into everyday airport operations and activities.

The goal of energy reduction is to reduce lifetime energy consumption of airport facilities. Energy reduction techniques have been proven to provide long-term, post-construction operational and maintenance benefits that will result in a net savings in energy usage. The following sustainable practices are examples of energy reduction strategies and best management practices that exemplify green and sustainable technologies applicable for facilities and roadway systems at airports.

- Refrigerant Management
    - Refrigerant management is achieved by eliminating use of chlorofluorocarbon (CFC)-based refrigerants in HVAC&R systems.

- Energy Optimization
    - Energy optimization is achieved by reducing, wherever possible, levels of energy consumed. This can be achieved through:
        - Create a master lighting plan.
            - Design lighting to provide luminance for safety, while limiting light pollution and reducing or conserving energy.
        - Design lighting systems to reduce lifetime energy consumption for facilities, parking lots, and roadways.
            - Install luminaires that meet or exceed the 2009 Energy Star standard.
            - Use alternative and/or high efficiency energy sources to power street lighting, warning signs, and other lighted components in order to reduce grid power consumption. High efficiency street lighting sources include (but are not limited to):
                - Light emitting diodes (LED).
                - Induction lamps.
                - New high intensity discharge (HID) lamp and ballast combinations.
                - Solar power.

- Replace traditional lighted signs with retro-reflective signs to eliminate both power consumption and light pollution associated with sign-lighting.
- Provide lamps that are Dark-Sky compliant or equivalent. A list of Dark-Sky approved fixtures is available at: www.DarkSky.org
- Install lighting sensors and controls.
- Provide for the ongoing accountability of lighting energy consumption over time through development and implementation of a measurement and verification (M&V) plan.

▪ Design electrical-powered systems to reduce lifetime energy consumption for occupied or non-occupied structures:
  - For all structures (occupied and non-occupied):
    - HVAC components.
      - Establish goal of zero use of CFC-based refrigerants in new systems.
      - When reusing existing equipment, complete a comprehensive CFC phase-out conversion prior to project completion.
    - Install vegetated or white-roof systems to reduce overall building energy consumption.
    - Provide high-efficiency motors and variable-speed pumping systems.
    - Use LED lighting wherever applicable.
    - Implement renewable energy strategies, as applicable, including solar (photovoltaic and thermal), wind, geothermal.
    - Begin the commissioning process early in the design process and execute additional activities after systems performance verification is completed.
    - Provide for the ongoing accountability of a structure's energy consumption over time through development and implementation of a M&V plan covering a period of no less than one year of post-construction.
  - For occupied buildings:
    - HVAC components
      - Establish goal of zero use of CFC-based refrigerants in new systems.
      - When reusing existing equipment, complete a comprehensive CFC phase-out conversion prior to project completion.
    - Install vegetated or white-roof systems to reduce overall building energy consumption.
    - Provide high-efficiency motors and variable-speed pumping systems.
    - Provide energy efficient lighting systems including LED, fluorescent lighting, solar lighting, and the use of lighting sensors or timers.

        - Organize circuiting of lighting and building systems so that individual areas may be separately controlled relative to daylight and heating/cooling zones.
        - Orient building to optimize passive solar and/or daylight penetration.
        - Optimize architectural features for daylighting and glare control. Consider light shelves, ceiling design, window placement, and window treatments
        - Provide Energy Star compliant equipment and appliances.
        - Control air infiltration through all exterior openings.
        - Evaluate appropriate levels of insulation for building envelope.
        - Verify that energy related systems are installed, calibrated. and perform according to project requirements, basis of design, and construction documents.
    - Commissioning of existing buildings (retrocommissioning)
        - Existing building commissioning is achieved through conducting an energy audit to document a building's or facility's energy use as compared to design specifications, implementing no or low-cost improvements immediately, and budgeting for future capital improvements to address major system upgrades, as necessary.

- On-Site and Off-Site Renewable Energy
    - Consider the following renewable energy initiatives, as appropriate:
        - Wind Power (wind turbines)
        - Photovoltaics (solar electric)
        - Electricity generation using bio-fuels (untreated wood waste, agricultural crops or waste, landfill gas)
        - Electricity generating wind turbines
        - Solar-thermal water or air heating
        - Geothermal heating systems
        - Geothermal electrical systems
        - Co-Gen
        - Micro-turbines
        - Hydroelectricity
        - Purchase of Green Power

- Emissions Reduction
    - Emissions can typically be reduced by the following activities:
        - Increase energy efficiency, including use of renewable energy.
        - Promoting use of public transportation or commuting.
        - Establish an anti-idling policy on airport property.
            - Require that vehicles dropping or loading passengers for departures or arrivals shut off their engines while their vehicle is stopped.

- Designate and encourage use of a cell phone lot.
- Provide premium parking spots for alternative fuel passenger vehicles.
- Install public-use electric vehicle charging stations.

▪ Encourage use of alternative fueled vehicles, such as CNG, ethanol, biodiesel, propane, hydrogen, electric.

- Encourage airport and tenant use of on- and off-road vehicles for regular daily activities that use ultra-low sulfur diesel (ULSD) fuel conforming to ASTM D975, D5453, D6078, and D613 or alternative fuel such as compressed natural gas (CNG), propane or biodiesel (B80 or greater)

NOTE: Ultra Low Sulfur Diesel (ULSD) fuel

U.S. Environmental Protection Agency (EPA) standards implemented over the last decade have required a major reduction in the sulfur content of diesel fuels and emission levels from diesel engines and vehicles. To meet the EPA standards, the petroleum industry is producing ultra low sulfur diesel (ULSD) fuel, a cleaner-burning diesel fuel containing a maximum 15 parts-per-million (ppm) sulfur. Used in combination with cleaner-burning diesel engines and vehicles, ULSD fuel helps to improve air quality by significantly reducing emissions.

Non-Road/Off-Road - Non-road diesel fuel was required to transition to 500 ppm sulfur in 2007, and further to ULSD (15 ppm sulfur) in 2010 with exceptions provided to small refiners and other exceptions in place through 2013. After December 1, 2014 all highway, nonroad, locomotive, and marine diesel fuel produced and imported will be ULSD. This additional reduction in sulfur levels will further reduce PM emissions from existing engines. More importantly, the ultra-low sulfur levels will make it possible for engine manufacturers to use advanced emission control systems that will achieve dramatic reductions in both PM and NOx emissions.

The goal of designing and constructing projects with energy reduction in mind is to reduce lifetime energy consumption of airport facilities. Energy reduction techniques employed in design and construction stages of a project meet short-term temporary sustainability goals, as well as provide long-term, post-construction operational and maintenance benefits that will result in a net savings in energy usage over time.

Sustainable initiatives for consideration at an airport that are related to designing for energy and atmosphere optimization include, but are not limited to those listed below. These initiatives can be incorporated into airport design and construction activities.

- Fundamental and Enhanced Building Systems Commissioning
    - Verify that the project's energy related systems are installed, calibrated, and performed according to the owner's project requirements, basis of design, and construction documents.
    - Designate an individual as the Commissioning Authority (CxA) to lead, review, and oversee the completion of the commissioning process activities
        - The CxA shall have documented commissioning authority experience in at least two building projects and should be independent of the project's design and construction management, though they may be employees of the firms providing those services. The CxA may be a qualified employee or consultant of the owner.
    - Develop and incorporate commissioning requirements into the construction documents.
    - Develop and implement a commissioning plan that includes the following systems:
        - High energy consuming systems:
            - Central building automation system
            - All HVAC system equipment
            - Lighting controls and sensors
            - Site lighting
            - Refrigeration systems
            - Vertical transport
            - Building envelope
            - Baggage handling systems
            - Information technology systems
        - Low energy consuming systems:
            - Emergency power generators and automatic transfer switching
            - Uninterruptible power supply systems
            - Life safety systems; fire protection fire alarm, egress pressurization
            - Lightning protection
            - Domestic and process water pumping and mixing systems
            - Equipment sound control systems
            - Data and communication systems
            - Paging systems
            - Security systems
            - Irrigation systems
            - Plumbing
            - Illuminated guidance signage
        - For Runways, civil/stormwater, and roadways/rail projects:
            - For support and ancillary buildings, include all of the applicable systems and assemblies noted above
            - Runway lighting and illuminated signage

        - Runway NAVAIDS
        - Site lighting systems
        - Traffic signals
        - Stations (e.g., pump stations, lift stations, drainage pumps)
        - Heating/deicing systems
        - Oil/water separators
    - Verify the installation and performance of the systems to be commissioned.
    - Complete a summary commissioning report that covers at least the following energy-related systems:
        - Heating, ventilating, air conditioning and refrigeration (HVAC&R) systems (mechanical and passive) and associated controls
        - Lighting and daylighting controls
        - Domestic hot water systems
        - Renewable energy systems (wind, solar, etc.)

- Optimize Energy Performance/Minimum Energy Performance
    - Establish the minimum level of energy efficiency for the proposed building and civil infrastructure systems to reduce environmental and economic impacts associated with excessive energy use.
    - Energy optimization is achieved by reducing, wherever possible, levels of energy consumed. This can be achieved through:
        - Create a master lighting plan.
            - Design lighting to provide luminance for safety, while limiting light pollution and reducing or conserving energy.
        - Design lighting systems to reduce lifetime energy consumption for facilities, parking lots, and roadways.
            - Install luminaires that meet or exceed the 2009 Energy Star standard.
            - Use alternative and/or high efficiency energy sources to power street lighting, warning signs, and other lighted components in order to reduce grid power consumption. High efficiency street lighting sources include (but are not limited to):
                - LED
                - Induction lamps
                - New HID lamp and ballast combinations
                - Solar power
            - In place of traditional lighted signs use instead retro-reflective signs to eliminate both power consumption and light pollution associated with sign-lighting.
            - Provide lamps that are Dark-Sky compliant or equivalent. A list of Dark-Sky approved fixtures is available at: www.DarkSky.org.
            - Install lighting sensors and controls.
            - Provide for the ongoing accountability of lighting energy consumption over time through development and implementation of a M&V plan.

- Design electrical-powered systems to reduce lifetime energy consumption for occupied or non-occupied structures:
    - For all structures (occupied and non-occupied):
        - HVAC components
            - Establish goal of zero use of CFC-based refrigerants in new systems.
            - When reusing existing equipment, complete a comprehensive CFC phase-out conversion prior to project completion.
        - Install vegetated or white-roof systems to reduce overall building energy consumption.
        - Provide high-efficiency motors and variable-speed pumping systems.
        - Use LED lighting, wherever applicable.
        - Implement renewable energy strategies, as applicable including solar (photovoltaic and thermal), wind, geothermal.
        - Begin the commissioning process early in the design process and execute additional activities after systems performance verification is completed.
        - Provide for the ongoing accountability of a structure's energy consumption over time through development and implementation of a M&V plan covering a period of no less than one year of post-construction.
    - For occupied buildings:
        - HVAC components
            - Establish goal of zero use of CFC-based refrigerants in new systems.
            - When reusing existing equipment, complete a comprehensive CFC phase-out conversion prior to project completion.
        - Install vegetated or white-roof systems to reduce overall building energy consumption.
        - Provide high-efficiency motors and variable-speed pumping systems.
        - Provide energy efficient lighting systems including LED, fluorescent lighting, solar lighting, and the use of lighting sensors or timers.
        - Organize circuiting of lighting and building systems so that individual areas may be separately controlled relative to daylight and heating/cooling zones.
        - Orient building to optimize passive solar and/or daylight penetration.
        - Optimize architectural features for daylighting and glare control. Consider light shelves, ceiling design, window placement, and window treatments.

  - Provide Energy Star compliant equipment and appliances.
  - Control air infiltration through all exterior openings.
  - Evaluate appropriate levels of insulation for building envelope.
  - Verify that energy related systems are installed, calibrated, and perform according to project requirements, basis of design, and construction documents.
- On-Site Renewable Energy
  - Consider the following renewable energy initiatives, as appropriate:
    - Wind power (wind turbines)
    - Photovoltaics (solar electric)
    - Electricity generation using bio-fuels (untreated wood waste, agricultural crops or waste, landfill gas)
    - Electricity generating wind turbines
    - Solar-thermal water or air heating
    - Geothermal heating systems
    - Geothermal electrical systems
    - Co-Gen
    - Micro-turbines
    - Hydroelectricity
    - Purchase of Green Power

- Fundamental and Enhanced Refrigerant Management
  - Refrigerant management is achieved by eliminating use of chlorofluorocarbon (CFC)-based refrigerants in HVAC&R systems.
  - Strive for zero use of CFC-based refrigerants in new base building HVAC&R systems.
    - When reusing existing base building HVAC equipment:
      - Complete a comprehensive CFC phase-out conversion prior to project completion.
      - Conduct an inventory to identify equipment that uses CFC-based refrigerants and provide a replacement schedule for these refrigerants.
      - For new buildings, specify new HVAC equipment in the base building that uses no CFC refrigerants.
  - Although HCFCs and HFCs have ozone depletion potentials (ODP) that are nearly zero, consideration should also be given to their global warming potentials (GWP).
    - Alternative refrigerants that minimize ODP and GWP compared to HCFCs and HFCs include natural refrigerants such as carbon dioxide, ammonia, and propane. These compounds have an ODP of zero and GWPs which are three orders of magnitude less than most HCFCs and HFCs.

- Measurement and Verification (M&V)
  - Provide for the ongoing accountability of building energy consumption over time.
  - Develop an M&V Plan to evaluate building and/or energy system performance.

        - Characterize the building and/or energy systems through energy simulation or engineering analysis.
        - Install continuous metering equipment for the following end-uses:
            - Lighting systems and controls
            - Constant and variable motor loads
            - Variable frequency drive (VFD) operation
            - Chiller efficiency at variable loads (kW/ton)
            - Cooling load
            - Air and water economizer and heat recovery cycles
            - Air distribution static pressures and ventilation air volumes
            - Boiler efficiencies
            - Building-related process energy systems and equipment
            - Indoor water risers and outdoor irrigation
        - Track performance by comparing predicted performance to actual performance, broken down by component or system as appropriate.
        - Evaluate energy efficiency by comparing actual performance to baseline.

- Green Power
    - For buildings, encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.
    - Determine the energy needs of the building and investigate opportunities to engage in a green power contract.
    - Green power is derived from solar, wind, geothermal, biomass or low-impact hydro sources.
    - Visit www.green-e.org/energy for details about the Green-e program
        - Green-e Energy is the nation's leading voluntary certification program for renewable energy. For over a decade, Green-e Energy has been certifying renewable energy that meets environmental and consumer protection standards that it developed in conjunction with leading environmental, energy and policy organizations. Green-e Energy also requires that sellers of certified renewable energy disclose clear and useful information to potential customers, allowing consumers to make informed choices.

B.8 Materials and Resources

The goal of using sustainable materials and resources in everyday activities and operations is to reduce the amount of ongoing waste and toxins generated on a daily basis that are hauled to and disposed of in landfills or incineration facilities. Sustainable initiatives for consideration at an airport that are related to materials and resources include, but are not limited to, those listed below.

- Solid Waste Management
    - Waste Stream Audit
        - Conduct a waste stream audit of a building’s, tenant’s or division’s entire ongoing consumables waste stream, with the exception of durable goods or construction waste.

        - Use the audit's results to establish a baseline for types/amounts of waste by weight or volume.
        - Identify opportunities for increased recycling and waste diversion.
        - Use the audit's results to develop a Waste Stream Master Plan to establish targets/strategies to reduce/eliminate certain types of waste.
    - To the greatest extent possible, divert solid waste streams to other on-site uses.
        - Recycling and Reuse Programs
            - Develop and implement a waste reduction/recycling/reuse program that diverts the following common items from landfills and incineration facilities:
                - Paper
                - Toner cartridges
                - Glass
                - Plastics
                - Cardboard
                - Metals
                - Batteries
                - Electronics
                - Light bulbs
                - Automotive fluids
                - Office equipment, such as computers, monitors, copiers, printers, scanners, and fax machines
                - Appliances, such as refrigerators, dishwashers, and water coolers
                - External power adapters
                - Televisions and other audiovisual equipment
                - Landscape waste
                - Food waste
            - Develop a waste tracking system and establish a designated sort area for all recyclable and reusable items.

- Local/Regional Materials
    - The intent of using local and regional materials and resources is to increase demand for products that are extracted, harvested or recovered, or manufactured within your local region (within a 500 mile radius), thereby supporting your local economy and the use of indigenous resources, as well as reducing the environmental impacts resulting from transportation of such products.

The goal of designing for use and reuse of sustainable materials and resources in airport construction activities, and future everyday activities, is to reduce the amount of ongoing waste and toxins generated on a daily basis that are hauled to and disposed of in landfills or incineration facilities. Sustainable initiatives for consideration at an airport that are related to materials and resources include, but are not limited to those listed below.

- Storage and Collection of Recyclables
    - Designate an area for recyclable collection and storage that is appropriately sized and located in a convenient area.
        - These areas would likely be designed and sized differently depending on the ultimate use and waste stream of the facility (e.g., terminal, airfield, office, airlines, concessionaires, cargo, hangar, etc.).
        - Identify local waste handlers and buyers for glass, plastic, office paper, e-waste, newspaper, cardboard, metals, fluids, fixtures, and organic wastes.
        - Instruct occupants, employees and contractors on the recycling procedures.
        - Consider employing cardboard balers, aluminum can crushers, recycling chutes and other waste strategies to further enhance the recycling program.
        - Reduce use of water bottles by enabling provisions for water dispensers for refills.
        - Reduce use of water bottles by providing area and collection capability on non-secured side of terminal to allow for the dumping of liquids and refill opportunity post security.

    - Recycle the following waste, whenever feasible:
        - Aluminum
        - Glass
        - Paper, newspapers, magazines and cardboard
        - Carpet
        - Wood (pallets/crates, etc.)
        - Food waste/grease and compostables
        - Organic waste and compostables
        - Gas and oil filters
        - Motor oil and Anti-freeze
        - Scrap metal
        - Batteries
        - Light bulbs
        - Toner cartridges
        - Tires
        - Electrical wiring
        - Electronics including monitors
        - Deicing fluid
        - Foreign object debris (FOD)

- Building and Infrastructure Reuse
    - Consider reuse of existing, previously occupied buildings, including structure, envelope and elements, and infrastructure.
        - Remove elements that pose contamination risk and upgrade components that would improve energy and water efficiency such as windows, mechanical systems and plumbing fixtures.
        - Upgrade outdated components

  - Evaluate relocation of existing structures for reuse (with special consideration of historical components).
  - Consider adaptive reuse of building(s)/structure(s) and potential relocation for the same program use.
  - Evaluate maximizing reuse of existing runway and other infrastructure (e.g., utilities, lighting, etc.).
  - Seek opportunities to improve the indoor/outdoor and structure sustainability elements, such as increasing daylighting, energy efficiency, low VOC finishes, and similar.
  - Evaluate opportunities for application of deconstruction techniques.

- Construction Waste Management
  - Divert construction and demolition debris from disposal in landfills and incineration facilities.
  - Redirect recyclable recovered resources back to the manufacturing process and reusable materials to appropriate sites.
  - Recycle and/or salvage non-hazardous construction and demolition debris.
  - Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site.
  - Specify minimum percentage debris to be recycled or salvaged.
  - Consider recycling cardboard, metal, brick, mineral fiber panel, concrete, plastic, wood, glass, gypsum wallboard, carpet, and insulation.
  - Keep in mind that construction debris processed into a recycled content may be a commodity with an open market value.
  - Designate a specific area(s) on the construction site for segregated collection and labeling of recyclable materials, and track recycling efforts throughout the construction process.
  - Identify construction haulers and recyclers to handle the designated materials. Note that diversion may include donation of materials to charitable organizations and salvage of materials on-site.
  - Implement deconstruction planning and techniques into all demolition activities. Careful and planned deconstruction of a facility can provide sustainable benefits related to disposal, reuse of materials, etc.
  - Ensure that employees are aware of waste management and recycling procedures.
  - Evaluate use, as appropriate, of pre-cast or pre-fabricated units whenever possible, to reduce on-site waste generation during construction.

- Balanced Earthwork
  - Divert soils from landfills, reduce transportation of soil to off-site locations, and maintain or make soil available for reuse on other on-airport projects, which can reduce the amount of transportation and disposal costs (both financial and environmental).

  - Evaluate opportunities for on-site soil management which may include infrastructure elevation changes, development of noise berms, considerations for landscaping needs, etc.
  - Use GPS systems during large-scale grading and earthwork operations.
  - Identify stockpile areas, as well as the potential reuse on concurrent projects.

- Aggregate Reuse
  - Promote the reuse of aggregate from on-airport property sources.
  - Identify aggregates present on-site that can be incorporated into the final development.
  - Identify possible uses of recycled aggregates within each project.
  - Where approved and appropriate, consider the use of warm mix asphalt (WMA) for paving, which allows for the use of higher quantities of recycled asphalt pavement (RAP, also known as asphalt grindings).

- Material Reuse
  - Reuse building materials and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources.
  - Identify opportunities to incorporate salvaged materials into the building design, and research potential material suppliers.
  - Consider salvaged materials such as beams and posts, flooring, paneling, doors and frames, masonry, fencing, metal railing, manhole frames, lids, and catch basin inlets.
  - Use a "virtual warehouse" to maintain a current listing of materials available for reuse on other projects.

- Specify Recycled Content of Materials
  - Establish a project goal for recycled content materials and identify material suppliers that can achieve this goal.
  - Consider the following major building components for specifying maximum recycled content:
    - Aggregate in cast in place concrete
    - Fly-ash in cast in place concrete
    - Aggregate in pre-cast concrete including site work and infrastructure piping
    - Fly-ash in pre-cast concrete including site work and infrastructure piping
    - Bituminous concrete pavement
    - Unit pavers
    - Steel reinforcement
    - Structural steel
    - Miscellaneous steel
    - Steel fencing and furnishings
    - Unit masonry
    - Ductile iron pipe
    - Aluminum products

        - Site generated broken concrete for gabions
        - Railroad rails
        - Railroad ties
        - Railroad track base material
        - Steel doors and frames
        - Aluminum doors and windows
        - Plaster
        - Terrazzo
        - Acoustical ceilings
        - Drywall
        - Finish flooring including carpet, resilient flooring and terrazzo
        - Toilet and shower compartments
        - Special finishes
    - During construction, ensure that the specified recycled content materials are installed and quantify the total percentage of recycled content materials installed.
    - Encourage aggressive use of permeable pavement with high recycled content, where applicable, such as recycled ground tire rubber (GTR) for permeable asphalt

      Additional guidance/information can be found online at:

      U.S. General Services Administration - Environmental Products Overview
      www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_OVERVIEW&contentId=9845
      Architectural Record – Green Product Guide
      www.archrecord.construction.com/products/green/

- Specify Use of Local/Regional Materials
    - The intent of using local and regional materials and resources is to increase demand for products that are extracted, harvested or recovered, or manufactured within your local region (within a 500 mile radius), thereby supporting your local economy and the use of indigenous resources, as well as reducing the environmental impacts resulting from transportation of such products.
    - Establish a project goal for locally sourced materials and identify materials and material suppliers that can achieve this goal.
        - Materials that may contribute toward this goal include, but are not limited to: concrete, aggregate, asphaltic products, structural steel, masonry, gypsum wallboard, utility structures (manholes, conduit, catch basins, culverts, sewer piping, stormwater piping, etc.), gas and water piping, landscaping materials. NOTE: Piping used indoors for building systems should not be included. Reused and salvaged materials also qualify.
        - Note that due to sole sourcing and limited availability, FAA equipment and specialty items sometimes cannot meet the 500 mile criterion.

  - During construction, ensure that the specified local materials are installed and quantify the total percentage of local materials installed.
  - Consider a range of environmental, economic and performance attributes when selecting products and materials.

- Specify Use of Rapidly Renewable Materials
  - Establish a project goal for rapidly renewable materials and identify products and suppliers that can support achievement of this goal.
  - Consider materials such as:
    - Poplar OSB
    - Straw board or "agriboard"
    - Bamboo flooring
    - Cork
    - Wool carpets and fabrics
    - Cotton-batt insulation
    - Linoleum flooring
    - Sunflower seed board
    - Wheat grass or straw board cabinetry and others.
    - Rice husks for concrete

- Specify Use of Certified Wood
  - Encourage environmentally responsible forest management.
  - Establish a project goal for FSC-certified wood products and identify suppliers that can achieve this goal.
  - During construction, ensure that the FSC-certified wood products are installed and quantify the total percentage of FSC-certified wood products installed.

- Equipment Salvage and Reuse
  - Promote the reuse of equipment and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources.
  - Identify opportunities to incorporate salvaged materials into the design, and research potential material suppliers. Consider salvaged materials such as cabinetry and furniture, pumps, motors, electrical panels, fixtures, and tanks
  - Explore and encourage the development of a virtual warehouse for salvaged and reusable items.

B.9 Indoor Environmental Quality

The goal of improving or maximizing indoor environmental quality is to contribute to the health and well-being of building occupants. Sustainable initiatives for consideration at an airport that are related to indoor environmental quality include, but are not limited to those listed below. These initiatives can be incorporated into everyday airport operations and activities.

- Outdoor Air Introduction and Exhaust System
    - Modify or maintain each outside air intake, supply air fan, and/or ventilation distribution system to supply at least the outdoor air ventilation rate required by ASHRAE 62.1—2007 Ventilation Rate Procedure under all normal operating conditions. (www.ashrae.org/technology/page/1412), or if that is infeasible due to physical constraints of the existing ventilation system, modify or maintain the system to supply at least 10 cubic feet per minute of outdoor air per person under all normal operating conditions.
    - Implement and maintain an HVAC system maintenance program to ensure the proper operations and maintenance of HVAC components as they relate to outdoor air introduction and exhaust.
    - Test and properly maintain the operation of all building exhaust systems.
    - To the greatest extent possible, install a Building Automation System to monitor and adjust outside air flow.

- Environmental Tobacco Smoke Control
    - Prohibit smoking in any building.
    - Designate exterior smoking areas at least 25 feet from building entries, outdoor air intakes, and operable windows.

- Occupant Comfort
    - Allow for occupant controlled lighting.
        - Allow for lighting control by individual occupants or specific groups in multi-occupant spaces to promote the productivity, comfort, and well-being of building occupants.
        - Provide task lighting or more light switching zones in office areas.
        - Design lighting control systems to take advantage of daylight harvesting to reduce artificial lighting when adequate daylight is available.
        - Provide operable windows in areas that are not noise-sensitive.
        - Design terminal areas to provide a variety of levels of light and sound in different areas simultaneously.
        - Tie lighting in public areas of passenger terminals to flight schedules or use motion-activated lighting.

    - Thermal comfort monitoring
        - Implement a system for continuous tracking and optimization of systems that regulate indoor comfort and conditions (air temperature, humidity, air speed and radiant temperature) in occupied spaces.
        - Install a permanent monitoring system to ensure ongoing building performance to the desired comfort criteria as determined by equipment manufacturer(s).
        - Periodically test air speed and radiant temperature in occupied spaces.
        - Install alarms for conditions that require system adjustment or repair.

        - Develop procedures that deliver prompt adjustments or repairs in response to problems identified.
        - Utilize a Building Automation System to monitor and control thermal comfort.

- Green Cleaning
    - Sustainable Cleaning Equipment
        - Reduce human exposure to potentially hazardous chemical, biological, and particulate contaminants that could adversely affect air quality, human health, and the environment.
        - Develop, implement, and maintain a policy for the use of low-impact powered cleaning equipment.
        - Evaluate the powered cleaning equipment currently being used and make a plan for upgrading to powered cleaning equipment that reduces building contaminants and minimizes environmental impact.
    - Cleaning and Maintaining Entryways
        - The intent is to reduce or eliminate contaminants from entering the building from the outside, to the greatest extent possible.
        - Use grilles, grates, or mats to catch and hold dirt particles and prevent contamination of interior space.
        - At public entrances:
            - Install low-maintenance vegetation within the landscape design and avoid plants, including trees and shrubs, that produce fruit, flowers, or leaves that are likely to be tracked into the space.
            - Base plant selection on an integrated pest management approach to eliminate pesticide applications that could be tracked into the space.
        - Provide a water spigot and electrical outlet at each entrance for maintenance and cleaning.

- High Performance Cleaning
    - Reduce human exposure to potentially hazardous chemical, biological, and particulate contaminants that could adversely affect air quality, human health, and the environment.
    - Designate cleaning techniques that promote the most efficient use of products, including the proper amount of product to use and proper wiping motion for certain tasks,
    - Specify cleaning techniques that promote the most efficient use of electricity, including only turning on lights in areas where active cleaning is taking place rather than turning on all lights throughout the space for the entire shift.
    - Provide proper training on supply usage, including when to replace paper products and liners as not to throw away usable product. For example, office trash liners that may need emptying but not replacing when possible.

- Specifying Minimum Indoor Air Quality (IAQ) Performance
  - The intent is to establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants.
  - Balance the impacts of ventilation rates on energy use and indoor air quality to optimize for energy efficiency and occupant health.
  - Design ventilation systems to meet or exceed the minimum outdoor air ventilation rates as described in the ASHRAE 62 Users Manual for detailed guidance on meeting the referenced requirements.
  - Identify potential IAQ conflicts on the site and locate air intakes away from air contaminant source, which might include loading areas, exhaust fans, and cooling tower.
  - Locate air intakes in secure areas for protection from potential security breaches.
  - Design HVAC systems to meet ventilation requirements of the referenced standard.
  - Evaluate carbon or electrostatic filters for use in passenger terminal buildings.
  - Provide a security monitoring system and restrict access to outdoor air intakes for passenger terminal buildings and any other public gathering areas.

- Outdoor Air Delivery Monitoring
  - Modify or maintain each outside air intake, supply air fan, and/or ventilation distribution system to supply at least the outdoor air ventilation rate required by ASHRAE 62.1—2007 Ventilation Rate Procedure under all normal operating conditions (www.ashrae.org/technology/page/1412), or if that is infeasible due to physical constraints of the existing ventilation system, modify or maintain the system to supply at least ten cubic feet per minute of outdoor air per person under all normal operating conditions.
  - Implement and maintain an HVAC system maintenance program to ensure the proper operations and maintenance of HVAC components as they relate to outdoor air introduction and exhaust.
  - Test and properly maintain the operation of all building exhaust systems.
  - To the greatest extent possible, install a Building Automation System (BAS) to monitor and adjust outside air flow.
  - Install carbon dioxide and airflow measurement equipment and interface with the HVAC system and/or BAS to trigger corrective action, if applicable. If such automatic controls are not feasible with the building systems, use the measurement equipment to trigger alarms that inform building operators or occupants in the event of a possible deficiency in outdoor air delivery.
  - Provide audible feedback to building occupants, who in turn know to inform the building's engineer, as a satisfactory means of meeting this aspect of the credit requirement for both the densely occupied areas and the other areas with mechanical ventilation systems.

  - Design HVAC systems for passenger terminal and other public assembly and buildings with carbon dioxide monitoring sensors in each space and integrate these sensors with the BAS.
  - Provide real-time control of terminal unit (VAV box) flowrates and total outdoor air flowrates based on carbon dioxide levels.

- Increased Ventilation
  - Provide additional outdoor air ventilation to improve indoor air quality for improved occupant comfort, well-being and productivity.
  - For mechanically ventilated spaces: Use heat recovery, where appropriate, to minimize the additional energy consumption associated with higher ventilation rates.
  - For naturally ventilated spaces: Follow the design steps described in the Carbon Trust Good Practice Guide 237.
  - Use public domain software to analytically predict room-by-room airflows. Examples include, but are not limited to the following:
    - NIST's CONTAM (Multizone Modeling Software): www.bfrl.nist.gov/IAQanalysis/CONTAM/
    - LoopDA (Natural Ventilation Sizing Tool): www.bfrl.nist.gov/IAQanalysis/software/LOOPDAdesc.htm
  - Select and place air diffusers for all mechanically ventilated spaces, particularly office and passenger terminal spaces, following the recommended design approaches in the ASHRAE 2001 Fundamentals, Chapter 32, Space Air Diffusion.
  - Section 6 of ASHRAE 62.1-2007 outlines guidelines for determining ventilation rates for various applications of mechanical ventilation systems.
  - Increase air change effectiveness using the following strategies:
    - Displacement ventilation in passenger terminal areas
    - Underfloor air distribution in office areas
    - Operable windows and skylights in cargo buildings
  - Increase air movement in cargo facilities with ceiling fans.
  - Install trickle ventilators in cargo facilities to provide natural winter ventilation.
  - Install relief vents or operable skylights in cargo facilities to provide stack effect natural ventilation.

- Construction IAQ Management Plan
  - During Construction
    - The intent is to reduce indoor air quality problems resulting from the construction/renovation process in order to help sustain the comfort and well-being of construction workers and building occupants.
    - Adopt an IAQ management plan to protect the HVAC system during construction, control pollutant sources, and interrupt contamination pathways. Sequence the installation of materials to avoid contamination of absorptive materials such as insulation, carpeting, ceiling tile, and gypsum wallboard.

        - If possible, avoid using permanently installed air handlers for temporary heating/cooling during construction. During construction meet or exceed the recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guideline for Occupied Buildings under Construction, 1995, Chapter 3.
        - Protect stored on-site or installed absorptive materials from moisture damage.
        - Do not operate air-handling equipment during construction.
        - Sequence the installation of materials to avoid contamination of absorptive materials such as insulation, carpeting, ceiling tile, and gypsum wallboard.
        - Minimize the use of air handlers during construction. If air handlers are used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 must be used at each return air grill, as determined by ASHRAE 52.2-1999.

    - Before Building Occupancy
        - Prior to occupancy, perform a building flush-out or test the air contaminant levels in the building. The flush-out is often used where occupancy is not required immediately upon substantial completion of construction. IAQ testing can minimize schedule impacts but may be more costly.
        - The intent is to eliminate indoor air quality problems that occur as a result of construction.
        - Replace all filtration media immediately prior to occupancy. Filtration media shall have a Minimum Efficiency Reporting Value (MERV) of 13, as determined by ASHRAE 52.2-1999 for media installed at the end of construction.
        - After construction ends and prior to occupancy, conduct a two-week building flush out with 100% fresh air.

- Specify Use of Low-Emitting Material
    - The intent is to reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants, including the following:
        - Adhesives and sealants
        - Paints and coatings
        - Flooring systems
        - Composite wood and agrifiber products
    - Specify low-VOC materials
    - Specify wood and agrifiber products with no added urea-formaldehyde resins.
    - Consider the use of air scrubbers during the installation and curing of adhesives and sealers when used inside the passenger terminal or other public spaces.
    - Specify that all shop finished material meet the VOC emission requirements. Materials to consider are:
        - Primed steel
        - Finished metals including aluminum
        - Finished millwork
        - Finished steel and wood doors and windows

- Indoor Chemical and Pollutant Source Control
  - Design facility cleaning and maintenance areas with isolated exhaust systems for contaminants.
  - Maintain physical isolation from the rest of the regularly occupied areas of the building.
  - Install permanent architectural entryway systems such as grills or grates to prevent occupant-borne contaminants from entering the building.
  - Install high-level filtration systems in air handling units processing both return air and outside supply air.
  - Ensure that air handling units can accommodate required filter sizes and pressure drops.
  - Where chemical use occurs (including housekeeping areas and copying/printing rooms), provide segregated areas with deck-to-deck partitions with separate outside exhaust at a rate of at least 0.50 cubic feet per minute per square foot, no air re-circulation, and maintaining a negative pressure.
  - Provide drains plumbed for appropriate disposal of liquid waste in spaces where water and chemical concentrate mixing occurs.
  - Select finish materials and assemblies that resist mold growth.
  - Designate central locations in terminal and office buildings for storage of concentrated cleaning chemicals and other pollutant sources.
  - Install permanent architectural entryway systems such as grills or grates to prevent occupant-borne contaminants from entering the building.
  - Design separate exhaust and plumbing systems for rooms or areas with contaminants to achieve physical isolation from the rest of the building.
  - Encourage the use of electric vehicle uses in indoor cargo facilities

- Controllability of Systems
  - Design to allow for occupant controlled lighting.
    - Allow for lighting control by individual occupants or specific groups in multi-occupant spaces to promote the productivity, comfort, and well-being of building occupants.
    - Provide task lighting or more light switching zones in office areas.
    - Design lighting control systems to take advantage of daylight harvesting to reduce artificial lighting when adequate daylight is available.
    - Provide operable windows in areas that are not noise-sensitive.
    - Design terminal areas to provide a variety of levels of light and sound in different areas simultaneously.
    - Tie lighting in public areas of passenger terminals to flight schedules or use motion-activated lighting.
  - Design to allow for occupant controlled thermal comfort.
    - Design the building and systems with comfort controls to allow adjustments to suit individual needs or those of groups in shared spaces.

- ASHRAE Standard 55-2004 identifies the factors of thermal comfort and a process for developing comfort criteria for building spaces that suit the needs of the occupants involved in their daily activities. Control strategies can be developed to expand on the comfort criteria to allow adjustments to suit individual needs and preferences.
    - These strategies may involve system designs incorporating operable windows, hybrid systems integrating operable windows and mechanical systems, or mechanical systems alone.
    - Individual adjustments may involve individual thermostat controls, local diffusers at floor, desk or overhead levels, or control of individual radiant panels, or other means integrated into the overall building, thermal comfort systems, and energy systems design.
    - Evaluate the closely tied interactions between thermal comfort (as required by ASHRAE Standard 55-2004) and acceptable indoor air quality (as required by ASHRAE Standard 62.1-2007, whether natural or mechanical ventilation).

▪ Establish comfort criteria per ASHRAE Standard 55-2004 that support the desired quality and occupant satisfaction with building performance. Design building envelope and systems with the capability to deliver performance to the comfort criteria under expected environmental and use conditions. Evaluate air temperature, radiant temperature, air speed, and relative humidity in an integrated fashion and coordinate these criteria with SAM Credits 6.1 Low-Emitting Materials, 6.3 Outdoor Air Delivery Monitoring and 6.4 Increase Ventilation.
▪ Provide ceiling fans or natural ventilation to increase air movement in cargo spaces.
▪ Provide humidification in HVAC systems serving office and terminal areas.
▪ For spaces with humidification, install humidistats in addition to thermostats.

o Design to allow for thermal comfort monitoring.
▪ Implement a system for continuous tracking and optimization of systems that regulate indoor comfort and conditions (air temperature, humidity, air speed, and radiant temperature) in occupied spaces.
▪ Install a permanent monitoring system to ensure ongoing building performance to the desired comfort criteria as determined by equipment manufacturer(s).
▪ Periodically test air speed and radiant temperature in occupied spaces.

        - Install alarms for conditions that require system adjustment or repair.
        - Develop procedures that deliver prompt adjustments or repairs in response to problems identified.
        - Utilize a BAS to monitor and control thermal comfort.

- Daylight and Views
    - The intent is to provide for building occupants, a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.
    - Design the building to maximize interior daylighting. Strategies to consider include:
        - Building orientation
        - Shallow floor plates
        - Increased building perimeter
        - Exterior and interior permanent shading devices
        - High performance glazing and automatic photocell-based controls
    - Design the building to maximize view opportunities.
    - Provide sky or clerestory lighting as appropriate in cargo and passenger terminal facilities.
    - Coordinate daylight strategy with BAS and lighting control system.
    - Provide exterior and interior permanent shading devices.
    - Provide spectrally selective glazing to maximize daylight while minimizing heat gain.
    - Provide photo-integrated light sensors to dim artificial lights.

- Noise Transmission
    - Design to limit noise levels in noise-sensitive, occupied spaces such as passenger terminals and offices to increase employee productivity and passenger comfort.
    - Design spaces in such a way as to orient noise sensitive areas away from major noise sources.
    - Use sound dampening glazing and wall partitions.
    - Locate copy machines and printers in separate rooms
    - For office environments, specify acoustical ceiling with an appropriate noise reduction coefficient to meet the requirements of this credit.
    - Choose cubicle partitions that are at least 5 feet tall to provide a sound barrier to workstation occupants.
    - Insulate wall cavities for noise sensitive spaces and extension of partition walls to the structural deck.
    - Specify laminated glazing to reduce noise transmission for normally occupied spaces.

B.10 Construction Practices

The goal of sustainable construction practices is to minimize the environmental impact of airport construction activities. Sustainable initiatives for consideration at an airport that are related to construction practices include, but are not limited to those listed below.

- Clean Fuel Construction Vehicles
  - The intent is to minimize air quality impacts during construction.
  - Specify that all off-road construction vehicles over 50 hp use ultra-low sulfur diesel (ULSD) fuel.
  - Restrict idling times.
  - Require all contractors to report fuel usage on a monthly basis.
  - Encourage contractors to identify and incorporate any other measures that may assist in reducing air quality emissions as a result of construction, examples include:
    - Encouraging use of cleaner vehicle options that now exist for employee shuttle buses and Light Duty Vehicles (LDVs), such as compressed natural gas (CNG), hybrid (fuel/electric), flex fuel, and demand on displacement.

- Construction Equipment Maintenance
  - The intent is to minimize the environmental impact of construction equipment maintenance activities
  - Develop and implement a BMP manual that includes the following, at a minimum:
    - Equipment vehicle washing restrictions
    - Equipment vehicle fueling controls
    - Equipment vehicle maintenance requirements
    - Above ground storage tank equipment requirements/spills
    - Mobile tank trucks (petroleum) requirements
    - Chemical handling/storage requirements
    - Drum storage procedures
    - Battery storage procedures
    - Truck loading/unloading procedures/spill control
    - Spill control kits and spill response
    - Good housekeeping procedures/waste storage
    - Storm drain protection/identification
  - Require contractors to comply with the BMP manual.

- Construction Activity Pollution Prevention/Systems Commissioning
  - For occupied buildings, verify that the project's energy related systems are installed, calibrated, and perform according to the owner's project requirements, basis of design, and construction documents.
  - The following commissioning process activities shall be completed by the commissioning team. Designate an individual as the CxA to lead, review, and oversee the completion of the commissioning process activities.
    - The CxA shall have documented commissioning authority experience in at least two building projects and should be independent of the project's design and construction management, though they may be employees of the firms providing those services. The CxA may be a qualified employee or consultant of the owner.

- The owner shall document the Owner's Project Requirements (OPR). The design team shall develop the Basis of Design (BOD). The CxA shall review these documents for clarity and completeness. The Owner and design team shall be responsible for updates to their respective documents
- Develop and incorporate commissioning requirements into the construction documents
- Develop and implement a commissioning plan that includes the following systems:
  - High energy consuming systems:
    - Central building automation system
    - All HVAC system equipment
    - Lighting controls and sensors
    - Site lighting
    - Refrigeration systems
    - Vertical transport
    - Building envelope
    - Baggage handling systems
    - Information technology systems
    - Low energy consuming systems
    - Emergency power generators and automatic transfer switching
    - Uninterruptible power supply systems
    - Life safety systems; fire protection fire alarm, egress pressurization
    - Lightning protection
    - Domestic and process water pumping and mixing systems
    - Equipment sound control systems
    - Data and communication systems
    - Paging systems
    - Security systems
    - Irrigation systems
    - Plumbing
    - Illuminated guidance signage
  - For Runways, Civil/Stormwater, and Roadways/Rail projects:
    - For support and ancillary buildings include all of the applicable systems and assemblies noted above
    - Runway lighting and illuminated signage
    - Runway NAVAIDS
    - Site lighting systems
    - Traffic signals
    - Stations (e.g., pump stations, lift stations, drainage pumps)
    - Heating/deicing systems
    - Oil/water separators
- Verify the installation and performance of the systems to be commissioned.
- Complete a summary commissioning report that covers at least the following energy-related systems:

        - Heating, ventilating, air conditioning and refrigeration (HVAC&R) systems (mechanical and passive) and associated controls
        - Lighting and daylighting controls
        - Domestic hot water systems
    - Renewable energy systems (wind, solar etc.)

- Low-Emission Construction Vehicles
    - The intent is to minimize air quality impacts during construction.
    - Encourage contractors to purchase new equipment or retrofit existing equipment to low-emission vehicles, such as:
        - Biodiesel (especially regionally derived biofuels)
        - Other regionally preferred alternative fuels
        - Diesel-electric hybrid vehicles
        - Where approved and appropriate, consider the use of WMA for paving, which reduces energy usage and emissions
        - GPS for optimizing haul routes and work activities
        - Stricter idling controls, including use of idling restrictors
        - Newest technology equipment and retrofits

- Alternative Transportation During Construction
    - Staging Area
        - Reduce emissions due to construction vehicles by minimizing the amount of traffic to the construction site.
        - Have a staging area where employees congregate prior to entering the project site.
        - Use multiple occupancy vehicles to access the project site from the centralized staging area.
        - Establish procedures and make vehicles available for employee car-pooling to the project site.
            - For maximum benefit, specify that shuttle buses or vans are preferred over lower occupancy vehicles such as pick-up trucks.

    - Low-Emitting and Fuel-Efficient Vehicles
        - The intent is to reduce emissions from on-road construction vehicles, such as foreman pickups or shuttle buses.
        - Specify that the contractor must use fuel efficient and low emitting vehicles for at least a minimum percentage of all on-road, contractor-owned construction vehicles that access the project site more than five calendar days per month.
            - Specify that vehicles must have an Air Pollution Score or a Greenhouse Gas Score of 6 or greater according to the U.S. EPA Green Vehicle Guide.

- Construction Material Conveyance
    - Reduce emissions from construction activities by minimizing the amount of on-road and off-road vehicle traffic traveling to/from the construction site.
    - Use an automatic materials conveyance system as a method for transporting materials to or from a construction site.

  - The primary focus of a conveyance system would be in those projects in which there is a large area requiring significant grading changes.
  - Construct Batch Plants as needed on- or near-site or utilize rail transport where available or appropriate.

- Construction Noise and Acoustical Quality
  - Improve the exterior noise quality during construction affecting residential areas or other noise sensitive areas.
  - Implement a noise abatement or noise mitigation plan that identifies site specific, mechanical, structural or operational measures to reduce noise disturbances in noise sensitive areas adjacent to the project site.
  - Require contractors to abide by the noise abatement or noise mitigation plan.

- Sustainable Temporary Construction Materials
  - Reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with high recycled content, rapidly renewable materials, and FSC certified wood products for temporary uses during construction.
    - Materials that may have high recycled content include, but are not limited to the following:
      - Temporary steel structures or materials
      - Fencing or metal barricades
      - Plastic traffic control devices (barricades, cones)
      - Temporary piping (HDPE, ductile iron)
      - Steel formwork
      - Plastic erosion control materials (e.g. silt fence)
    - Materials that have rapidly renewable materials include, but are not limited to:
      - Poplar oriented strand board (OSB) for formwork or temporary carpentry
      - Coir or jute fabric erosion control blankets and meshes
      - Plant-based cladding and insulation materials
      - Contractor trailer materials such as flooring and finishes
    - FSC certified wood products for temporary construction materials may include:
      - Wood formwork
      - Temporary wood structures or scaffolding

B.11 Encourage Tenants and Concessionaires to Operate Sustainably

The goal of encouraging concessionaires and tenants to operate sustainably is to raise awareness of the airport's overall goals and to fully integrate sustainability into all aspects of the airport's everyday activities, not only into those activities under the airport's direct control. This can be achieved by recommending administrative items and procedures that promote workplace practices, procedures, and material use to reduce the use of energy, water, and materials. Sustainable initiatives for an airport that encourage concessionaires and tenants to operate sustainably include, but are not limited to those listed below.

- Encourage development of a corporate sustainability policy and/or sustainability vision statement.
    - Encourage concessionaires and tenants to establish and adopt an overall corporate sustainability policy and/or sustainability vision statement that focuses on the role and impact of the organization in the workplace, marketplace, environment, and community.

- Encourage development of a green procurement policy.
    - Encourage tenants to reduce the environmental impact of products and services by developing and implementing a Green Purchasing Program, which can be accomplished by:
        - Introducing environmentally conscious purchasing into organizational practices.
        - Clearly defining objectives.
        - Establishing a sustainability-claims verification procedure that can be replicated as necessary.
        - Evaluating items that are purchased and identifying more environmentally friendly alternatives, along with establishing a policy to purchase these alternatives when economically feasible. This might also require working with suppliers to identify sustainable products that meet the organization's needs.

      Note: the following resources can be used to create a procurement policy. Resources include but are not limited to:

      U.S. EPA's Environmentally Preferable Purchasing (EPP) Program guidelines: www.epa.gov/epp

      U.S. EPA's Comprehensive Procurement Guidelines (CPG) includes an index of products and their recommended recycled content: www.epa.gov/epawaste/conserve/tools/cpg/products/index.htm

      U.S. EPA's Water Sense program promotes water efficiency and enhances the market for water-efficient products, programs and practices: www.epa.gov/WaterSense/

      DOE's Alternative Fuels and Advanced Vehicles Data Center provides a wide range of information and resources to enable the use of alternative fuels, as well as other options to reduce petroleum use, including advanced vehicles, fuel blends, idle reduction, and fuel economy: www.afdc.energy.gov/afdc/

      Fair Trade Products purchased in place of regular products builds equitable and sustainable trading partnerships: www.fairtradefederation.org

      USDA's BioPreferred Designated Products Program is designed to increase the purchase and use of renewable, environmentally friendly bio-based products, while promoting a green marketplace: www.catalog.biopreferred.gov/bioPreferredCatalog/faces/jsp/catalogLanding.jsp

- Encourage use of green meetings practices.
    - Encourage tenants to establish and implement green meeting practices, which are intended to guide meeting hosts, planners, and attendees toward more eco-friendly meetings. Strategies include, but are not limited to:
        - Reduce the number of copies of meeting materials by asking participants to share meeting materials; digitize materials and distribute presentations via email prior to the meeting, place/project materials on the wall (one large print or presented with projector equipment).
        - If handouts are needed at the meeting, produce handouts locally, double-sided, high post-consumer recycled content paper/chlorine-free paper, vegetable-based inks, print in draft mode (uses less ink).
        - Recycle or save for future reuse, all materials following the meeting.
        - Allow participants who would travel to/from the meeting to participate via phone or internet instead.
        - If travel cannot be avoided, encourage carpool or public transportation.

- Encourage Development of a Document Reduction Recycling Initiative (DRRI)
    - The intents are to reduce the volume of paper used and to facilitate document recycling.
        - Identify and issue only essential paper copies.
        - Designate centralized review rooms for documents and drawings to eliminate the need for multiple paper copies.
        - Encourage recycling of all documents by asking reviewers to return obsolete documents for recycling.

- Encourage planning, design, construction, and daily operation of tenant spaces with sustainability in mind.
    - The intent is to encourage tenants to integrate sustainability considerations and goals into the planning process for all projects; design, implementation, and operational stages, regardless of size and scope.
    - Major elements of a sustainable planning process include, but are not limited to:
        - Determine key stakeholders and hold initial project meeting to discuss sustainability goals of the project.
        - Conduct sustainability baseline assessment and cost/benefit analysis.
        - Develop a sustainability schematic to guide how sustainability goals are to be met throughout the project.
        - Hold a project meeting with key stakeholders to finalize sustainability schematic.

        - Gather feedback at project completion by holding a meeting with key stakeholders to identify successes, opportunities for improvement, and lessons learned.
- By encouraging tenants to integrate sustainable elements into the design process as early as possible, the effectiveness of enhancing a project's sustainability is maximized while costs due to design and construction changes are minimized.
- By encouraging tenant to carry out everyday activities in a sustainable manner, there is a reduction of environmental impacts of the day-to-day activities, as well as a reduction of impacts to their buildings' functional life cycles.

APPENDIX C

Resources and References

A review of sustainability-related literature, research, published guidance, and other materials was completed in order to gain an understanding of the most current information and materials relevant to sustainable practices at airports, as well as sustainable practices in use at non-airport industries that would be applicable to airports. The results, drawn from numerous public and private-entity sources, are presented here.

Published Documents: Literature, Research, Guidance

#	Title	Author	Publisher	Volume	Issue	Date	Web Address	Brief Synopsis	Key Word(s)
1	Airport Carbon Accreditation	Developed by ACI Europe					http://www.airportcarbonaccreditation.org/	Assesses and recognizes the efforts of airports to manage and reduce their carbon emissions with four levels of awards: mapping (footprint measurement) reduction (carbon management towards a reduced carbon footprint), optimization (third party engagement in carbon footprint reduction) and neutrality (carbon neutrality for direct emissions by offsetting).	Carbon Emissions, Mapping, Reduction, Optimization, Neutrality
2	Airport Energy Efficiency and Cost Reduction; A Synthesis of Airport Practice	Craig R. Lau, Joel T. Stromgren, and Daniel J. Green, Miller Dunwiddie Architecture, Minneapolis, MN	ACRP, Synthesis 21	1		2010	http://onlinepubs.trb.org/onlinepubs/acrp/acrp_syn_021.pdf	This report documents energy efficiency improvements being implemented at airports across the country that are low cost and short payback by means of a survey, interviews, and a literature review. It targets small airport terminal managers, staff, consultants, and other stakeholders interested in energy efficiency. The report includes some assessments of cost and benefits for individual measures.	Energy, Efficiency, Improvement, Airports, Cost, Payback, Survey, Interview, Literature Review, Terminal, Consultants, Assessment
3	Airport Sustainability Practices; A Synthesis of Airport Practices	Fiona Berry, Sarah Gillhespy, and Jean Rogers, Arup North America, Ltd., San Francisco, California	ACRP, Synthesis 10	1		2008	http://onlinepubs.trb.org/onlinepubs/acrp/acrp_syn_010.pdf	This synthesis study informs about a range of airport sustainability practices gathered from a literature review and web-based survey. It specifically targets airport operators and provides a snapshot of airport sustainability practices across the triple bottom line of environmental, economic, and social issues. Information used in this study was acquired through a review of the literature and interviews with airport operators and industry experts.	Synthesis, Airport, Sustainability, Literature, Web, Operators
4	Capital Program Sustainable Design Guidance Manual	Gresham Smith and Partners	Columbus Regional Airport Authority			Feb 2008	http://www.columbusairports.com/construction/CRAA-Capital-Program-Guidance-Manual.pdf	Written to apply the LEED rating system's concepts to the terminal, airside, and landside projects at Port Columbus International Airport, Rickenbacker International Airport and Bolton Field Airport.	LEED, Terminal, Airside, Landside, Port Columbus, Rickenbacker, Bolton Field
5	Collaborative Environmental Management Plan (CEM)	European Organization for the Safety of Air Navigation (EUROCONTROL)				2008	http://www.eurocontrol.int/environment/gallery/content/public/documents/CEM_final_17%2011%2008.pdf	A commonly agreed strategic management process for establishing an airport environmental partnership between the key operational stakeholders at an airport. This partnership will prioritize and meet environmental challenges caused by the direct environmental impacts of aircraft operations.	Strategic, Management, Partnership, Airport, Environmental, Stakeholders, Aircraft, Operations
6	Continuous Descent Approach	European Organization for the Safety of Air Navigation (EUROCONTROL)				2008	http://www.eurocontrol.int/environment/gallery/content/public/documents/cda_brochureA4_may08_web.pdf	The objective of a CDA is to reduce aircraft noise, fuel burn and emissions by means of a continuous descent, so as to intercept the approach glide path at an appropriate height for the distance to touchdown.	Continuous, Descent, Approach, Reduce, Noise, Fuel, Emissions, Glide Path, Touchdown
7	Designing for Energy Efficiency	Food Marketing Institute				2010	www.epa.gov/greenchill/downloads/Designing%20for%20Energy%20Efficiency_2010FMI.pdf	It is recommended that large-scale facilities, which experience higher energy costs than nearly other building types, gain efficiency from integrated design practices, including systems to control heat gain, such as double glazed windows. Unmanaged solar energy through the use of standard single glazed windows can increase the heating load of a facility, demanding more of the air conditioning systems.	Double-glazing, Solar Energy, Heat Gain
8	Double-Sided Printing	Appropedia				2011	http://www.appropedia.org/Double-sided_printing	The benefits of double-sided printing include cost savings, reduced waste, and improved carbon footprint.	Double-Sided Printing
9	Environmental Management Primer	Dallas Fort Worth International Airport	Dallas Fort Worth International Airport			Apr 2009	http://www.dfwairport.com/dfwucm1prd/groups/public/documents/webasset/p1_027449.pdf	A concise tool for identifying the environmentally regulated aspects of operations, commercial and construction activities conducted on-Airport.	Environmentally, Regulated, Operations, Commercial, Construction, Airport
10	European Airport Greenroofs- A Potential Model for North America	Valezquez, Linda S.	Greenroofs.com			Updated Feb, 2008	http://www.greenroofs.com/pdfs/exclusives-european%20_airport_greenroofs.pdf	A case study for the implementation of airport greenroofs worldwide.	Airport, Greenroofs
11	FAA Sustainable Master Plan Pilot Program	Federal Aviation Administration (FAA)				2010	www.faa.gov/airports/environmental/sustainability/	The FAA recently introduced the Sustainable Master Plan Pilot Program. This program is evaluating ways to make sustainability a core objective at every airport by funding long-range planning documents at 10 airports around the country. These documents, called Sustainable Master Plans and Sustainable Management Plans, will include initiatives for reducing environmental impacts and achieving economic benefits while increasing integration with local communities. The program will end in late 2012. We will use lessons learned to develop national program guidance on airport sustainability.	FAA, Sustainable Master Plan, Sustainability Plan Pilot Program, Airport Sustainability
12	For Airports and Airlines, Creative Recycling Brings Cost Savings	Harriet Baskas	USA Today			May 12, 2010	www.usatoday.com/travel/columnist/baskas/2010-05-12-airport-recycling-programs_N.htm"	Examples of social sustainability initiatives in place at airports.	Airport Recycling, Airline Recycling, Recycling, Recycling Cost Savings

Published Documents: Literature, Research, Guidance									
#	Title	Author	Publisher	Volume	Issue	Date	Web Address	Brief Synopsis	Key Word(s)
13	Global Reporting Initiative (GRI)	Large multi-stakeholder network of thousands of experts, in dozens of countries worldwide, who make up GRI's working groups and governance bodies, use the GRI Guidelines to report, access information in GRI-based reports, or contribute to develop the Reporting Framework in various other ways, both formally and informally.				2007	www.globalreporting.org	Vision: The Global Reporting Initiative's (GRI) vision is that disclosure on economic, environmental, and social performance become as commonplace and comparable as financial reporting, and as important to organizational success. Mission: GRI's mission is to create conditions for the transparent and reliable exchange of sustainability information through the development and continuous improvement of the GRI Sustainability Reporting Framework.	GRI, Global Reporting Institute, Sustainability Reporting Framework
14	Going Green: Motivations for Environmental Commitment in the Airline Industry. A case Study of Scandinavian Airlines	Lynes, J. K. Dredge, D.	Channel View Publications	14, NUMB 2, pgs 116-138		2006	http://www98.griffith.edu.au/dspace/bitstream/10072/13361/1/39607.pdf	A case Study of Scandinavian Airlines (SAS) examines an airline's decision-motivations for environmental commitment. An in-depth analysis of the drivers identified by both SAS and related industry officials shows that attitudes, values and beliefs generated both internally and externally have a critical impact on the airline's environmental policy-making.	Airlines, Scandinavia, Drivers, Environmental, Policy, Attitude, Value, Belief
15	Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage	Daniel Esty and Andrew Winston	John Wiley & Sons, Inc.	2nd Printing		2009	www.eco-advantage.com/	Guidance designed for business leaders who recognize the importance of folding environmental thinking into strategy.	Green to Gold, Corporate Environmental Strategy, Environmental Thinking
16	Greening Your Purchase of Cleaning Products: A Guide for Federal Purchasers	U.S. Environmental Protection Agency				2012	http://www.epa.gov/epp/pubs/cleaning.htm"	Green Purchasing, also known as Environmentally Preferable Purchasing, or EPP, seeks the overall best value, taking into account price competitiveness, availability, regulatory requirements, performance, and environmental impact.	Green Cleaning, Green Purchasing, Environmentally Preferable Purchasing, EPP
17	GreenLITES (Green Leadership In Transportation Environmental Sustainability)	New York State Department of Transportation				2008-2010	https://www.nysdot.gov/programs/greenlites	Transportation environmental sustainability rating program. is a self-certification program that distinguishes transportation projects and operations based on the extent to which they incorporate sustainable choices. This is primarily an internal management program for NYSDOT to measure our performance, recognize good practices, and identify where we need to improve. It also provides the Department with a way to demonstrate to the public how we are advancing sustainable practices. NYSDOT project designs and operations are evaluated for sustainable practices and based on the total credits received, an appropriate certification level is assigned. The rating system recognizes varying certification levels, with the highest level going to designs and operational groups that clearly advance the state of sustainable transportation solutions.	Transportation, Environmental, Sustainability, Rating, System, New York, Self-Certification, NYSDOT, Sustainable Transportation
18	Greenroads Rating System	The University of Washington, CH2M Hill, and Martina Soderlund				2007	www.greenroads.us/	Greenroads™ is a voluntary sustainability rating system, or "performance metric," for roadway design and construction. It is applicable to all roadway projects including new, reconstructed and rehabilitated roadways. It awards points for sustainable choices/practices and can be used to assess roadway project sustainability.	Green, Roads, Sustainable Roads, Highways, Roadway Design, Roadway Construction, Roadway Design and Construction, Rating System, Sustainable Roads Rating System

Published Documents: Literature, Research, Guidance									
#	Title	Author	Publisher	Volume	Issue	Date	Web Address	Brief Synopsis	Key Word(s)
19	How Energy-Efficient Light Bulbs Compare with Traditional Incandescents	U.S. Department of Energy				2012	http://www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=12060"	Table comparison of Indoor 60 watt (W) traditional incandescent bulbs with energy efficient bulbs that provide similar light levels.	Lighting, incandescent, bulbs, energy efficient bulbs
20	How to Reduce Printing costs by 17%: A Guide to Doing Well and Doing Good by Printing Less	GreenPrint Technologies				2008	http://www.printgreener.com/pdfs/GreenPrint%20White%20Paper%20September%2008.pdf	Actively managing office printing can reduce spending on document output Annual paper costs can be reduced by by selecting double-sided printing as the default for all document output; Success will be enhanced by gaining support from Senior Management for such initiatives and informing all employees of the purpose.	Office printing, Office Practices, Administrative Procedures, Greening the Office
21	Illinois – Livable and Sustainable Transportation Rating System (I-LAST)	Illinois Department of Transportation Division of Highways and Illinois Joint Sustainability Group				Jan 2010	http://www.dot.il.gov/green/documents/I-LASTGuidebook.pdf	The purpose of this guide is threefold: 1. Provide a comprehensive list of practices that have the potential to bring sustainable results to highway projects. 2. Establish a simple and efficient method of evaluating transportation projects with respect to livability, sustainability, and effect on the natural environment. 3. Record and recognize the use of sustainable practices in the transportation industry. The use I-LAST is purely voluntary on the part of the jurisdictional agency for which a project is being developed and completed. Joint issuance of the guide on the part of the Illinois Department of Transportation shall not be construed as a requirement of its use on any state highway project.	Illinois Roads Sustainability, Livability, IDOT, ILAST, Sustainable Highway Projects
22	International Organization for Standardization 26000 Social Responsibility	International Organization for Standardization (ISO)	International Organization for Standardization (ISO)	ISO 26000		Nov 2010	http://www.iso.org/iso/social_responsibility	Provides guidance to both business and public sector organizations on social responsibility.	ISO, ISO 26000, Social, Responsibility, Business Responsibility, Public Sector Responsibility
23	LEED Reference Guide for Green Building Design and Construction	U.S. Green Building Council	U.S. Green Building Council		2009 Ed.		www.usgbc.org	Reference guide for LEED credit system and certification for LEED for New Construction, LEED for Schools, and LEED for Core & Shell.	LEED, USGBC, Green, Building, Design, Construction, Schools
24	Model for Improving Energy Use in U.S. Airport Facilities	Dr. W. Dan Turner, Energy Systems Laboratory at Texas A&M University	ACRP, Project 11-02	1		Dec 2007	http://www.trb.org/Main/Public/Blurbs/159312.aspx	This brochure provides data on U.S. airports' utilization of 11 major energy management practices, offers a set of best practices for reducing energy use, and summarizes three case studies of recent recommissioning projects that resulted in significant reductions in energy use. Appendixes A through D of the report—respectively, "Study of Terminals B and D at Dallas/Fort Worth International Airport"; "Airport Rental Car Facility Case Study"; "Continuous Commissioning of the Matheson Courthouse in Salt Lake City, Utah"; and "Airport Survey Questionnaire"—are available online.	Airport, Utilization, Energy, Management, Practices, Reduce
25	Pacific Northwest National Laboratory Grounds Maintenance, BMP Case Studies #4 and #5 - Water Efficient Landscape and Irrigation	U.S. Department of Energy, Federal Energy Management Program				2009	www.nrel.gov/docs/fy09osti/46336.pdf"	Pacific Northwest National Laboratory (PNNL) operates an award-winning grounds maintenance program that comprises a comprehensive landscape and irrigation management program. The program has helped the laboratory reduce its water use for irrigation by 30%.	Water Efficiency, Outdoor Water Efficiency, Water Efficient Landscaping
26	A Paradigm Shift Toward Sustainable Transport	K. Sakamoto, D. Dalkmann, D. Palmer	Institute for Transportation and Development Policy			Aug 2010	http://www.itdp.org/documents/A_Paradigm_Shift_toward_Sustainable_Transport.pdf	Initial attempt to identify the challenges and actions needed to finance the paradigm shift towards sustainable, low-carbon transport in developing countries. It is meant to be a living document, to which further work by SLoCaT members can be added.	Challenges, Finance, Low-Carbon, Transport, Developing, SLoCaT
27	Recycling and Environmental Facts	Eco-cycle				2012	www.ecocycle.org	Website developed and maintained by non-profit recycler working toward building zero waste communities.	Recycling, Environmental Facts, Zero Waste
28	The Social Benefits of Sustainable Design	U.S. Department of Energy, Federal Energy Management Program				2003	www1.eere.energy.gov/femp/program/sustainable_businesscase.html"	Provides significant financial evidence from research findings and case studies that sustainable design is a smart business choice.	Social Sustainability, Social Benefits, Sustainable Design
29	Sustainability "How-To Guide" Series- ENERGY SAVINGS GUIDE	Christine Doonan, Jim Volkman, Alan Kakaley, Brad Weaver	IFMA Foundation			2010	http://www.ifmafoundation.org/documents/public/NoCostLowCostGuide.pdf	The goal of the guide is to provide facility operations personnel with a practical document that will provide the resources to initiate no-cost/low-cost energy-efficiency measures at their sites. This is not a theoretical piece, but aims to present specific maintenance targets in a "here's where to go, here's what to look for" format.	Facility, Operations, Personnel, no-cost/low-cost, Maintenance
30	Sustainability "How-To Guide" Series- FOOD SERVICE ENVIRONMENT	Angela Lewis, Kathleen Cacciola, Robert B. Dennill	IFMA Foundation			2009	http://www.ifmafoundation.org/documents/public/FoodServiceGuide.pdf	This guide provides practical, real-world guidance on how to introduce and advance sustainable practices within the food service environment. The guide provides direction for individuals in leadership and management positions within the food service environment, as well as general information for professionals within the operation and management of buildings.	Sustainable, Food, Service, Operation, Management
31	Sustainability "How-To Guide" Series- LIGHTING SOLUTIONS	Bill Conley	IFMA Foundation			2010	http://www.ifmafoundation.org/documents/public/LightingGuide.pdf	This guide has been written to explain the benefits of investigating and upgrading lighting systems in and around facilities	Lighting, System, Upgrade

Published Documents: Literature, Research, Guidance									
#	Title	Author	Publisher	Volume	Issue	Date	Web Address	Brief Synopsis	Key Word(s)
32	Sustainability "How-To Guide" Series- SUSTAINABLE LANDSCAPING	Steven W. Gustafson, Randy Zellers, Kent Miller	IFMA Foundation			2010	http://www.ifmafoundation.org/documents/public/Landscaping.pdf	Sustainable landscaping balances environmental, economic and social needs of the facility. The goal of this guide is to help facility managers, and those who work with facility managers, to better understand what sustainable landscaping is and how to apply sustainable landscaping practices.	Sustainable, Landscaping, Environmental, Economic, Social
33	Sustainability "How-To Guide" Series- WATER CONSERVATION	David Cosaboon, Edward Jarger, Gary Klein, Patrick Okamura, Mike Warren, Rob Zimmerman	IFMA Foundation			2010	http://www.ifmafoundation.org/documents/public/WaterGuide.pdf	This guide is designed to review the basics of water use and disposal in commercial buildings.	Water, Usage, Disposal, Commercial
34	Sustainability Action Plan	American Society of Civil Engineers (ASCE)	American Society of Civil Engineers (ASCE)			2009	www.asce.org/Content.aspx?id=7232	Guiding Principles (parameters placed on the strategy managers): Consider the technical, environmental, economic, social, and political dimensions while ethically and responsibly carrying out the actions; Proactively seek collaborative opportunities domestically and internationally with other disciplines and organizations.	Sustainability Action Plan, Engineers, ASCE
35	Sustainability Trends at Airports- Reducing Emissions	Trendowski, John	airportmagazine.net			2008	http://www.cscos.com/pdf/articles/AirportMagazineSustainabilityArticle.pdf	Highlights the biggest threats to sustainability and suggests means of minimize those issues.	Sustainability, Threats, Minimize
36	Sustainable Airport Manual (SAM)	Chicago Department of Aviation	Chicago Department of Aviation		Version 2.0	2010	www.airportsgoinggreen.org	The purpose of the SAM is to integrate airport-specific sustainable planning and practice early in the design process, through construction, operations, maintenance and all airport functions with minimal impact to schedule or budget. The SAM is intended to be a "living document," one that will continue to grow and evolve, to include emerging new technologies, state-of-the-art design and thought-provoking principles as they develop. We are looking ahead to the future and working with industry experts, airport and airline professionals to collaborate on best practices and lessons learned from airports around the world.	SAM, Sustainable, Planning, Construction, Operations, Maintenance, Minimal, Impact, Future, Collaborate, Airports
37	Sustainable Airport Planning, Design and Construction Guidelines	LAWA (Los Angeles World Airports)	LAWA (Los Angeles World Airports)	4		Apr 2009	http://www.lawa.org/uploadedFiles/LAWA/pdf/Sustainable%20Airport%20PDC%20Guidelines%20Jan08.pdf	The Guidelines can be used by LAWA and other airports nationwide to integrate sustainable practices into projects, measure and communicate progress and continually improve their planning, design and construction processes.	LAWA, Guidelines, Sustainable, Planning, Design, Construction
38	Sustainable Alternative Fuels Progress Paper					2010	http://www.sustainableaviation.co.uk/images/stories/key%20documents/sustainable%20alternative%20fuels%20progress%20paper%20summer%202010.pdf	Aviation fuels derived from biomass will form a key component of the industry's long-term sustainable growth, complementing advances in engine and airframe technology, operational practices and air traffic management.	Fuel, Biomass, Sustainable, Engine, Airframe, Technology, Operational, Air Traffic, Management
39	Sustainable Aviation Guidance Alliance (SAGA)	Volunteer participants include representatives from Airports Council International-North America (ACI-NA); the Airport Consultants Council (ACC); the American Association of Airport Executives (AAAE); the Air Transport Association (ATA); the Federal Aviation Administration (FAA) and consultants that represent the participating associations.				2008	www.airportsustainability.org	The Sustainable Aviation Guidance Alliance (SAGA) is a broad volunteer coalition of aviation interests formed in 2008 to assist airport operators of all sizes in planning, implementing, and maintaining a sustainability program. SAGA has undertaken an effort to consolidate existing guidelines and practices into a comprehensive, searchable resource that can be tailored to the unique requirements of individual airports of all sizes and in different climates/regions in the United States.	Sustainable, Aviation, Guidance, Alliance, SAGA, Database, Sustainability Database, Searchable Sustainability Database
40	Sustainable Transport Magazine	Institute for Transportation and Development Policy	Institute for Transportation and Development Policy			Issued yearly.	http://www.itdp.org/documents/st_magazine/ST21_Winter09.pdf	Provides in-depth examination of worldwide transportation practices, showcases replicable alternatives, and highlights the efforts of sustainable transport advocates.	Transportation, Sustainable, Alternatives

Published Documents: Literature, Research, Guidance									
#	**Title**	**Author**	**Publisher**	**Volume**	**Issue**	**Date**	**Web Address**	**Brief Synopsis**	**Key Word(s)**
41	The Triple Bottom Line	Andrew W. Savitz with Karl Weber	Jossey Bass			2006	http://getsustainable.net/	The centerpiece of *The Triple Bottom Line* is the concept of sustainability. In the business world it denotes a powerful and defining idea: a sustainable corporation is one that creates profit for its shareholders while protecting the environment and improving the lives of those with whom it interacts. It operates so that its business interests and the interests of the environment and society intersect. As shown in the book, a sustainable business stands an excellent chance of being more successful tomorrow than it is today, and remaining successful, not just for months or even years, but for decades or generations.	Triple Bottom Line, Business Sustainability, Corporate Sustainability, Sustainable Corporation
42	Transportation and Sustainability Best Practices Background	CH2M Hill, Good Company	American Association of State Highway and Transportation Officials			May 2009	http://environment.transportation.org/pdf/sustainability_peer_exchange/AASHTO_SustPeerExh_BriefingPaper.pdf	Provides background about key leading practices and methods that transportation professionals are using to address sustainability issues relating to transportation.	Transportation, Practices, Sustainability
43	Trash Landing: How Airlines and Airports Can Clean Up Their Recycling Programs	Atkin, Peter	NRDC			2006	http://www.nrdc.org/cities/recycling/airline/airline.pdf	Study done by the Natural Resources Defense Council. Study focuses on the largely under developed airport and airline recycling programs and suggests how airports can achieve higher recycling rates (Statistics and figures are outdated, but suggestions and techniques are still applicable).	Natural, Resource, Defense, Council, Underdeveloped, Recycling
44	A Vision of 2014 and Beyond; Environmental Strategy Plan 2009	Seattle-Tacoma International Airport	Port of Seattle	1		2009	http://www.portseattle.org/downloads/community/environment/airport-envirostrategy.pdf	The airport's environmental strategy plan is a roadmap for achieving its environmental vision. It provides a framework for annual planning, budgeting, and accountability by identifying the measurable environmental outcomes that we aspire to achieve by 2014. The Plan is organized around three themes: *Moving People and Goods Efficiently*, *Managing Natural Resources Wisely*, and *Promoting Sustainable Communities*. Good summaries and example metrics for each impact area.	Environmental, Strategy, Vision, Framework, Planning, Budgeting, Accountability, Measurable, Outcome, Efficiency, Resources, Sustainable, Communities, Summary
45	Water Reuse Guidelines (Draft)	Farr & Associates	Public Building Commission of Chicago			Aug 2010 Draft	http://www.pbcchicago.com/	A handbook of guidelines for water reuse in Chicago.	Water, Reuse, Rainwater, Harvesting, Greywater, Graywater, Black water, PBC, Public Building Commission
46	WaterSense	U.S. Environmental Protection Agency				2012	www.epa.gov/watersense	Information regarding how to save water and protect the environment by choosing "WaterSense" labeled products in homes and businesses; and taking simple steps to save water each day.	Water, Water Use, Water Use Reduction
47	Windows and Offices: A Study of Office Worker Performance and Indoor Environment	Heschong Mahone Group, Inc.	California Energy Commission			Oct 2003		This study reports on a statistical investigation into the influences indoor physical environment has on office worker performance, especially daylight and view, and secondarily ventilation and thermal comfort.	Daylight, Offices, Worker Performance, LEED, Views, Study, Indoor, Environment, Heschong, Mahone

Airport Initiatives and Other Industry Initiatives: Non-Published									
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1	Green airport initiatives for the middle east	Abu Dhabi (AUH)	Nahla Nabil	Environmental & Health Safety Manager	+971 (2) 505-3457	nnabil@adac.ae	www.adac.ae	International commercial service airport, has goal to be the leading example "Green Airport" of the Middle East with goals for all aspects of administration, operations, maintenance, planning, design and construction to be performed to the highest and best standards of Sustainability Practices.	Abu Dhabi, Airport, Green, Middle, East, Administration, Operations, Maintenance, Planning, Design, Construction, Sustainability
2	Sustainability Plan at a General Aviation Airport	Aspen-Pitkin County Airport	Jim Elwood	Director of Aviation	970-920-5384		www.aspenairport.com	The Airport is in the process of creating an Evolving Sustainability Program that will focus on the primary goals of economic viability, operational efficiency, natural resource conservation and social responsibility. The program will include long and short term goals and metrics to measure the success of these goals as they are implemented	Aspen, Aspen Airport, Airport, General, Aviation, Assessment, Document, Sustainability, Evolving Sustainability Program, economic, operations, social responsibility, metrics, sustainability goals
3	Innovative Stormwater Reduction (Infiltration, Storage & Reuse)	Athletic Field / Golf Course Design - to be determined by M+M & Primera						Athletic fields and golf courses are an expanse of flat land that has to handle a large volume of stormwater. Their designs often include storage and reuse of stormwater in large quantities for irrigation. Their designs also incorporate innovative stormwater infiltration methods. These technologies and strategies are very comparable to handling stormwater on air fields.	Stormwater, storage & reuse, irrigation
4	Innovative utility systems and solar energy purchase at mid-size commercial service airport	Austin/Bergstrom (AUS)	Kane Carpenter	Environmental Conservation Program Manager	512-530-6621	Kane.Carpenter@ci.austin.tx.us	http://www.ci.austin.tx.us/austinairport/nr_award.htm	Mid-size commercial service airport, innovative utility systems, energy efficient terminal, purchases solar energy, CNG shuttle buses.	Austin, Bergstrom, Commercial, Airport, Energy, Efficiency, Solar, CNG
5	LEED Certified Terminal and CO_2 reducing runway pavement	Boston (BOS)	Kent Turner	HOK's Director of Transportation	212-741-1200	kent.turner@hok.com	http://www.sustainablebusiness.com/index.cfm/go/news.feature/id/1358	Large commercial service airport, environmental management system, advanced technology, LEED certified terminal, new runway paving that reduces 4,000 tons of carbon dioxide.	Boston, Airport, Commercial, Environmental, LEED, Carbon Dioxide
6	Thermal Storage application at an airport and all electric GSE	Chicago Midway (MDW)	Erin O'Donnell	Managing Deputy Commissioner	773-838-0608	erin@cityofchicago.org	www.flychicago.org	Mid-size commercial service airport, implementing Sustainable Airport Manual (SAM), thermal storage, all electric GSE, wind turbines, green roof.	Midway, Airport, Chicago, Commercial, SAM, Thermal, GSE, Wind, Turbine, Green, Roof
7	First U.S. airport with LEED Certified Air Traffic Control Tower	Chicago O'Hare (ORD)	Rosemarie S. Andolino	Commissioner	773-686-8060	rsandolino@cityofchicago.org	www.flychicago.org	Large commercial service airport, developed and implementing Sustainable Airport Manual (SAM), North ATC tower is the nation's first to be LEED certified, native and drought-tolerant vegetation, local construction materials, recycled construction materials, encourage tenants to build LEED standard buildings, 6 green roofs installed to-date, 5 green-roofs in the design/construction phases.	Chicago, O'Hare, Airport, SAM, LEED, ATC, Vegetation, Recycled, Green, Roof
8	Millennium Park Bicycle Commuter Station	Chicago, IL Department of Transportation	Janet Attarian	Project Director	312-744-5900	janet.attarian@cityofchicago.org	http://www.il-sustainablecommunity.com/pdfs/Sustainable_Communities_Program.pdf	This facility was designed to provide amenities to bicycle commuters in Downtown Chicago. It includes storage for 300 bikes, shower and locker facilities, bike repair, rest rooms and headquarters for the Chicago Lake Front Police.	Bicycle, Commuter, Station, Chicago, Shower, Locker, Repair, Police, Headquarters
9	Water harvesting and reuse	Chicago, IL Park District Facilities	Khatija Hashmy	Architect	312-742-4711	khatijahashmy@chicagoparkdistrict.org	http://www.chicagoparkdistrict.com/	Water harvesting (roof-rainwater-capture) and reuse incorporated into design prototypes.	Water, Harvesting, Chicago, Park, District, Roof, Rainwater, Capture
10	CleanAir CABS	City of Boston	Paul O'Connor	Boston Police Department-Hackney Division	617-343-4475	taxi.bpd@cityofboston.gov	http://www.bphc.org/programs/cib/environmentalhealth/Forms%20%20Documents/Boston%20CleanAir%20CABSB.pdf	Initiative in the City of Boston for taxi drivers to switch to hybrid cars: environmental benefits for the city of Boston and financial benefits for the taxi cab owners (ie. Hybrids burn less gas).	Boston, Taxi, Hybrid, Environmental, Financial
11	Green airport initiatives in China	Civil Aviation Administration of China (CAAC)	Geoff Jackson, USTDA	Director for Policy and Program and Regional Director for East Asia and Eurasia Region	703-875-4357	info@ustda.gov	www.ustda.gov	Includes several international commercial service airports (existing and emerging); CAAC has "Green Airport" goals of Savings, Environmental Protection, Scientific Progress, and Human Orientations to be achieved through the establishment and application of industry standards, rules and regulations, and other policy reform to the design/construction and operations/maintenance of all CAAC airport facilities.	Civil, Aviation, Administration, China, CAAC, Green, Airport, Environmental, Scientific, Orientations, Standards, Rules, Regulations, Design, Construction, Operations, Maintenance

Airport Initiatives and Other Industry Initiatives: Non-Published									
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12	Sustainable Education	Comfort Stations/ West Ridge Elementary	Terry Sullivan	Architect	312-432-4180	tsullivan@muller2.com	www.muller2.com	M+M has incorporated public education for sustainable practices and technologies for projects with the Chicago Park District and Chicago Public Schools in 2010. Each project takes a unique focus on the audience that occupies the building and lessons about sustainability to be learned by all ages. The concepts for educating the public about sustainability by using the building itself as a teaching tool can be applied to marketing sustainable practices and technologies in airports.	Sustainability, Education, Public, Teaching Tool,
13	Rainwater / Storm Water Reuse	CPD Comfort Stations/ CPS West Ridge Elementary / Center on Halsted	Stuart Bailin	Engineer, Water Harvesting Solutions, Inc.	630-235-2845	stuartb@wahaso.com	www.wahaso.com	Each of the three projects listed use the same rainwater harvesting system manufacturer in Chicago. These systems are among the first to be permitted and installed in public buildings in Chicago. Each of the three systems varies in complexity,, showing a range of rainwater and storm water reuse systems available for application on any number of scales.	Chicago, Rainwater, Harvesting, Water, Reuse, Storm water,
14	Sustainable Building Materials	CTA Subway projects	Terry Sullivan	Architect	312-432-4180	tsullivan@muller2.com	www.muller2.com	CTA Subway stations have to be one of the most challenging applications to test architectural materials for their integrity. Subway projects use a set of highly sustainable materials that can handle the stress of an underground public environment. This case study will draw from M+M's experience with transportation and public projects to create a collection of recommended sustainable materials and finishes for airports.	Sustainable Materials, CTA, Subway, Transportation Architecture
15	Sustainable Airport Planning Process and advanced sustainability initiatives	Dallas/Ft. Worth (DFW)	James Crites	Executive Vice President of Operations	972-973-5220	jcrites@dfwairport.com	www.dfwairport.com	Large commercial service airport, sustainability "first-mover," systems commissioning, energy master plan, reuse construction materials, reverse osmosis treatment plant that reduces waste from deicing operations by more than 90%.	Dallas Fort Worth Airport, Commercial, Master, Plan, Reuse, Construction, Reverse, Osmosis, Plant, Deicing
16	Renewable Energy Joint Venture	Frankfurt (FRA)	Peter Marx	Vice President of Environmental Management	+49 (0) 69-690-63108	p.marx@fraport.de	http://www.fraport.com/cms/sustainability/rubrik/22/22307.sustainability.htm	International commercial service airport, agreement in place with a renewable energy joint venture to explore and develop the potential of the geothermal field south of the airport. If proven feasible, the partners will construct a hybrid power plant that will combine geothermal power and biogas to produce electricity and heat for the airport.	Frankfurt Airport, Renewable, Energy, Joint, Venture, Geothermal, Hybrid, Power, Electricity, Heat
17	UK sees one-off "perfect flight"	Heathrow Airport (UK)	NATS-National Air Traffic Services, LTD.		01489616001 (UK)		http://www.enviro.aero/blog/2010/07/uk-sees-one-off-perfect-flight.html	Data was collected from a "perfect flight," where every possible factor was taken into consideration to produce the first "perfect flight"- result: nearly 1 tonne of CO_2 was eliminated.	Perfect, Flight, CO_2, NATS
18	Hazardous Waste recycling at non-airport application	Household Hazardous Waste Recycling, Chicago, IL	Andrew Sebescak	Sr. Vice President of Commissioning	312-242-6361	asebescak@primerachicago.com	http://www.primerachicago.com/index/	Energy recovery through solar wall installation to preheat outside air. The first of its kind in Chicago.	Household, Hazardous, Waste, Recycling, Chicago, Preheat, Air, Solar, Wall
19	Sustainable Airport Master Plan	Ithaca Tompkins Regional Airport	Robert Nicholas	Airport Director		bnicholas@tompkins-co.org	www.flyithaca.com	Ithaca Tompkins Regional Airport, Ithaca, New York, has designed its latest master plan update with sustainability in mind. The Federal Aviation Administration agreed to fund this sustainable master plan as the first in the U.S. The project was the first to integrate sustainability directly into the entire master planning process, instead of having a stand-alone sustainability plan.	Ithaca, Tompkins Airport, New York, Sustainable Airport Master Plan, FAA Sustainable Master Plan
20	Innovative HVAC/BAS and daylighting	Judson University, The Weber Academic Center (Elgin, IL)	Curtis Sartor	Dean, Judson University College of Architecture	847-628-1017	csartor@JudsonU.edu		The Weber Academic Center is the only passively heated and cooled building of its kind in the U.S. Designed by British architect Alan Short, this LEED Gold certified facility utilizes advanced passive forced air techniques and a building automation system to control thermal comfort on its four floors. A central atrium acts as the fresh air supply, which is conditioned in the basement level ceiling plenum space. The atrium uses the stack effect to draw conditioned air upwards to the floors. Each floor has windows hydraulically controlled by the BAS to open when that particular floor needs to draw conditioned air from the atrium. Air is captured and recycled at the top floor and sent back down to the basement through integrated building ducts. The passive techniques are finely tailored for the Midwestern climate, making for a highly efficient facility.	Passive Heating, Passive Cooling, HVAC, BAS, Building Automation System, Forced Air, Earth Duct, Atrium, Judson, University, College of Architecture, Library, Weber, Academic Center, LEED, Gold, Alan Short
21	Photovoltaic Field at non-airport application	Lexington Pumping Station, Illinois	Andrea Putz	Director of Water Research & Development	312-742-1070	andrea,putz@cityofchicago.org	http://www.cityofchicago.org/city/en/depts/water.html	Photovoltaic field converts solar energy to electricity to power a $12.9 million backup power facility. One of the largest such installations in the Midwest.	Lexington, Pumping Station, Chicago, Photovoltaic, Solar Facility
22	Photovoltaics / Solar Power	Lincoln Hall, University of Illinois at Chicago	John Hiltscher	Office of Capital Programs	312-413-1360		www.uic.edu	Lincoln Hall is an academic building on UIC's campus that has undergone a LEED Gold Certified renovation. It has a new 51.52 kW array of 224 solar panels installed on the roof.	UIC, University of Illinois, Lincoln Hall, LEED, Renovation, Photovoltaic, Solar Panels, Grid, Sun

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23	Large commercial service airport with airport-wide sustainable best practices	Los Angeles (LAX)	Intissar Durham	Chief Airports Engineer II	424-646-5841	idurham@lawa.org	http://www.lawa.org/welcomelax.aspx	Large commercial service airport, implementing sustainable best practices airport-wide, 35% landscaped areas irrigated with reclaimed water, removed 2,200 pounds of mercury from equipment, 13.5% of LAX's power is green power, 63% of LAWA vehicles are run on alternative fuel.	Los Angeles, LAWA, Commercial, Airport, Irrigation, Reclaimed, Mercury, Green, Alternative, Fuel
24	Wind Power	Midway Airport Elevated Parking Structure (Chicago, IL)	Tom McFall	CARE - JOC Project Manager	773-894-3616	Thomas.McFall@CARE-CM.Org		A LEED certified parking structure was equipped with wind turbines mounted to the parapet to generate energy to power lighting in the parking structure. M+M completed a full investigation of wind power options for this application. M+M completed construction drawings, permitting, and construction administration for the installation of 24 wind turbines at Midway Airport.	Midway Airport, Chicago, Wind, Power, Turbine
25	Mid-sized commercial service airport with airport-wide sustainable best practices and tenant buy-in	Oakland (OAK)	Kristi McKinney	Aviation Planning and Development Manager	510-627-1178	kmckenne@portoakland.com	http://www.flyoakland.com/noise/environmental.shtml	Mid-size commercial service airport, photovoltaic power, ceiling tiles and wall wainscot made from recycled materials, promotes CNG vehicles, employee tri-reduction program, free electric vehicle charging stations, solar-power on top of FedEx cargo building, bike paths that link terminals with the surrounding cities, airline consolidated waste and recycling program (highest rate of waste reduction, VHB), restored wetlands. LEED Certified Silver Terminal Building.	Oakland Airport, Commercial, Photovoltaic, Wainscot, Recycled, CNG, Electric Vehicles, Solar, LEED, Wetlands
26	Geothermal application at an airport	Paris Orly (ORY)	Maison de l'Environnement	Department of Environment	01-49-75-90-70	mdeorly@adp.fr	http://www.aeroportsdeparis.fr/Adp/en-GB/Group/Sustainablegrowth/	International commercial service airport, first European airport to use geothermal heating. $17 million project slated for completion in 2011 and anticipated to cut annual CO_2 emissions from 20,000 tons to 7,000 tons. Airport has aggressive goals to increase energy efficiency 20% by 2020 and 40% by 2040.	Paris Orly Airport, Geothermal, Heating, CO_2 Emissions, Energy Efficiency
27	Hydroelectric plants at a general aviation airport using existing streams	Paulding Northwest (PUJ)	Blake Swafford	Airport Director	770-505-7700	bswafford@paulding.gov	www.pauldingairport.com	General Aviation airport with plan to build mini hydroelectric plants using existing streams to create electricity.	Paulding Northwest, General Aviation, Airport, Hydroelectric Plant
28	Chicago Police Station building sustainability features	Police Station Prototype Design, Chicago, IL	Kenneth Panucci	Senior Vice President	312-606-0910	kpanucci@primerachicago.com	http://www.primerachicago.com/index/	Sustainable features incorporated into design prototypes: low-flow/no-flow plumbing fixtures, CHP systems with energy recovery, solar thermal systems, improved ventilation effectiveness and systems to monitor indoor comfort and building energy usage.	Police Station, Chicago, Prototype, low-flow/no-flow, Plumbing, CHP, Energy, Solar, Thermal, Ventilation
29	Geothermal application at an airport	Portland International Jetport, Portland, Maine (PWM)	Paul Bradbury	Airport Director	207-874-8877	phb@portlandmaine.gov	http://www.portlandjetport.org/	$2.5 million federal grant awarded in March 2010 to City of Portland, Maine for use in developing geothermal heating system at the jetport. Geothermal installation is part of the current $75 million airport expansion.	Portland, Geothermal, Heating, Jetport, Expansion
30	Large commercial service airport with airport-wide sustainable best practices	San Francisco (SFO)	Sam Mehta	Environmental Services Manager	650-821-7841	sam.mehta@flysfo.com	www.flysfo.com	Large commercial service airport, central power supplied to gates, transit for employees, conversion to CNG vehicles, Zero Waste Plan, new Terminal 2 projected to be built with LEED Silver standard, energy efficient lights, 50,000 sq.ft. of solar panels.	San Francisco Airport, Commercial, Transit, CNG, LEED, Solar
31	Sustainability Plan at a General Aviation Airport	Santa Monica (SMO)	Robert Trimborn	Airport Director	310-458-8591	bob.trimborn@smgov.net	http://www.smgov.net/departments/airport/	General Aviation airport created extensive sustainability plan that includes elements such as air quality, noise, open space, water, urban runoff, hazardous materials, construction practices, transportation, public participation, advocacy.	Santa Monica General Aviation Airport, Sustainability, Air Quality, Noise, Water, Urban, Runoff, Hazardous, Construction, Advocacy
32	Large commercial service airport with airport-wide sustainable best practices	Seattle (SEA)	Elizabeth Leavitt	Director of Aviation Environmental Programs	206-433-7203	leavitt.l@portseattle.org	www.portseattle.org	Large commercial service airport, sustainability "first-mover," environmental program management, recycling 1200 tons per year, light retrofitting, improved HVAC and escalator efficiency.	Seattle Airport, Sustainability, Management, Recycling, HVAC, Escalator
33	Controlled Modulus Columns	Soils/Weekhawken Town Houses (Manhattan Skyscrapers) by DGI Menard	Jason Griffin	Estimating Manager	440-357-6900	jgriffin@menardusa.com	http://www.dgi-menard.com/tc/article%20US.pdf	Controlled Modulus Columns (CMC) is a construction technique used to lay the foundation for buildings- since the technique involves neither driving nor vibration and creates no appreciable spoil, the environment is unaffected.	Controlled Modulus Columns, Construction, Foundation, Vibration, Driving, Environment

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34	Sustainable General Aviation Terminal Development	Springfield-Branson (SGF)	Gary Cyr	Director of Aviation	417-868-0500	info@flyspringfield.com	www.flyspringfield.com	General Aviation airport, new terminal will consist of ozone friendly water chillers, heat with natural gas, drainage system to store deicing fluids for ten days to become harmless to the environment.	Springfield Branson Airport, Ozone, Chillers, Natural Gas, Drainage
35	Sustainability Vision and Assessment Tool	St. Augustine-St. Johns County (SGJ)	Bryan Cooper	Assistant Airport Manager	904-209-0090	jbc@sgj-airport.com	www.flynf.com	General Aviation airport, created a vision and assessment tool to document airport's resource consumption and status of sustainability.	St. Augustine-St. Johns Airport, General Aviation, Assessment, Document, Sustainability
36	International commercial service airport with airport-wide sustainable best practices	Stockholm Arlanda (ARN)	Christina Sares	Environmental Advisor	08-797 86 83	Christina.Sares@swedavia.se	http://www.arlanda.se/en/Information-about/Environmental/	International commercial service airport, includes highly automated airside ramp operations, biogas used with many airport vehicles, including employees and passengers, all taxis to be eco-friendly by mid-2011, Sweden's largest installation of energy-efficient lighting (LED) completed.	Stockholm Arlanda Airport, Biogas, Eco-Friendly, Energy Efficiency, Automated
37	Double Skin System	Terrence Donnelly Centre for Cellular and Biomolecular Research on the University of Toronto's St. George Campus	Benhisch Architekten, Boston Office	Architect	617-375-9380		www.behnisch.com	The Donnelly Centre at the University of Toronto utilizes an advanced double skin building envelope for active and passive heating and cooling strategies. This project received international recognition and is worthy of further investigation. A double skin system is also applicable to airport terminals and office buildings.	Double skin, building envelope, active heat, passive heat, active cooling, passive cooling
38	Sustainability program at mid-sized commercial service airport.	Teterboro (TEB)	Arlyn Purcell	Supervisor of Environmental Programs	212-435-3844	arlynpurcell@comcast.net	http://www.panynj.gov/airports/	Mid-size commercial service airport operated by Port Authority of New York/New Jersey and included in PANYNJ sustainability program – climate change, air quality, energy reduction initiatives.	Teterboro Airport, Commercial, Port Authority, New York, New Jersey, PANYNJ, Climate, Energy
39	Green Roofs	West Ridge Elementary School (Chicago, IL)	Terry Sullivan	Architect	312-432-4180	tsullivan@muller2.com	www.muller2.com	Green roofs are growing in popularity and there are numerous manufacturers that make 3 main green roof systems: Intensive, Extensive, and Tray Systems. West Ridge Elementary school features two of the three green roof types in a recently built project.	Green Roof, Plants, Vegetated Roof, Intensive, Extensive, Tray
40	International commercial service airport with airport-wide sustainable best practices	Zurich (ZRH)	Emanuel Fleuti	Head of Environment	+41 (0) 43-816-21-81	emanuel.fleuti@@zurich-airport.com	http://www.zurich-airport.com/	International commercial service airport, mid-field pier constructed during 5th Expansion incorporates many sustainable design features, annual sustainability/ environmental reports, air quality monitoring system, highest rate of recycling with 40% waste recycled (VHB), purchases geothermal energy.	Zurich Airport, Sustainable, Design, Environmental, Air Quality, Recycling, Geothermal

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation